CARBON CHEMISTRY IN THE CONFLUENCE AREAS OF THE BRAZIL AND MALVINAS CURRENTS IN THE SOUTH WESTERN ATLANTIC OCEAN: THE RESULTS OF THE CONFLUENCE-89 EXPEDITION IN SEPTEMBER, 1989

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INTRODUCTION

This report summarizes the results of measurements of the CO_2 partial pressure (pCO_2) and total CO_2 concentration (TCO_2) in discrete seawater samples collected during the CONFLUENCE-2 Expedition, September 4 through September 13, 1989, in the southwestern Atlantic Ocean. It has been shown (Takahashi and Chipman, 1985; Peng and Takahashi, in press) that the confluence areas of the Brazil and Malvinas (or Falkland) Currents represent one of the most intense oceanic sink areas for atmospheric CO_2. This has been attributed to the juxtaposition of two effects contributing for reduction of pCO_2 in surface ocean water: 1) the cooling of the warm Brazil Current water as it flows southward, and 2) the photosynthetic utilization of CO_2 as the nutrient-rich sub-Antarctic water flows northward. This investigation has been undertaken in collaboration with Drs. Veronique Garcon and Christine Provost of CNES/GRGS in order to elucidate the carbon dioxide chemistry in the confluence zone.

ACKNOWLEDGMENTS

We gratefully acknowledge financial support of the Centre National de la Recherche Scientifique, Paris, FRANCE, for the field work. Support for the post-expedition data analysis has been provided by funds from the EXXON Research Foundation. We are grateful to vital assistance provided by Dr. Alberto Piola, Hydrographic Office, Argentine Navy, and Dr. Sylvia Garzoli, Lamont-Doherty Geological Observatory, for successful completion of this project. The hydrographic data (temperature, salinity, pressure and the concentrations of oxygen and nutrient salts) listed in this report have been provided by Alberto Piola and Veronique Garcon.

ANALYTICAL METHODS FOR CARBON CHEMISTRY

1) Partial Pressure of CO_2 in Seawater and Air Samples:

The net transfer flux of CO_2 (F) between the surface ocean water and the overlying air is determined by:

$$F = E * [(pCO_2)_{air} - (pCO_2)_{sw}] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where E is the air-sea CO_2 gas transfer rate constant and $(pCO_2)_{air}$ and $(pCO_2)_{sw}$ are respectively the CO_2 partial pressure in air and surface ocean water. The magnitude of E depends mainly on the turbulence of the interface and may be evaluated as a function of wind speed (e.g. Liss and Merlivat, 1986, Peng and Takahashi, in press, Tans et al., 1990). The pCO_2 values in air and seawater are measured in samples according to the method briefly described below.

A parcel of seawater sample (about 4 liters) is first isolated in a equilibration vessel (about 4.5 liters). About 1 liter of carrier gas (i.e. uncontaminated marine air) is recirculated for about 15 minutes in a closed system using a small gas circulation pump through a gas disperser immersed in the seawater sample. The circulating air is chemically equilibrated with the water sample during this period. Because of the large thermal inertia of the water sample, its temperature remains nearly constant within about 0.2 °C. The temperature of water is measured to $\pm$0.1 °C at the end of each equilibration process, and recorded. The equilibrated gas sample is isolated in a gas sampling flask (about 250 ml) equipped with stopcocks at each end, and shipped back to our land-based laboratories for the pCO_2 determination. In this way, the partial pressure of CO_2 exerted by a sample water is transferred to a gas sample, which can be stcred stably and reliably for a long period of time. After the gas samples are returned to our laboratory, they are analyzed for CO_2 using a gas chromatograph.

The gas chromatograph is similar to that described by Weiss (1981). The CO_2 molecules mixed with hydrogen gas are converted quantitatively to methane using a catalytic column of ruthenium, and the methane molecules produced are detected by a flame-ionization detector. The chromatograph itself yields a precision of about $\pm$0.0 6% for CO_2 analyses, and is calibrated using the WMO standard air-CO_2 mixtures analyzed by C. D. Keeling of SIO.

The gas sample isolated from the equilibrator and injected into the chromatograph for CO_2 analysis is saturated with water vapor at the equilibration temperature. Since the chromatograph measures the number of CO_2 molecules in a known volume of the sampling valve at a known

temperature, the measurement yields pCO_2 directly rather than the mole fraction of CO_2 in dry equilibrated carrier gas. All the determinations of pCO_2 have been performed at least in duplicates. The pCO_2 value thus obtained represents those at the equilibration temperature for each sample, and hence needs to be corrected to the in situ water temperature. The in situ pCO_2 values have been obtained using a temperature coefficient of 0.0423 /°C, which has been determined experimentally by Chipman and Takahashi (in preparation). All the pCO_2 values reported in this report represent those at the in situ temperature. Based upon the duplicate samples collected during the expedition, the overall reproducibility of pCO_2 measurements in seawater has been estimated to be $\pm$2 uatm on the average.

Samples of marine air were also collected during the expedition in gas sampling flasks (about 250 ml). These samples were first dried by passing through a column of P_2O_5, and analyzed for CO_2 using the gas chromatograph. The observed values are listed in Table 1. The pCO_2 value in air saturated with water vapor at the sea surface temperature was then computed using the barometric pressure and the temperature and salinity of surface water measured at the sampling location. The following equation was used for this purpose:

$$(pCO_2)_{air} = (VCO_2)_{air} \cdot (Pb - Pw), \quad \ldots\ldots(2)$$

where $(VCO_2)_{air}$ is the mole fraction concentration of CO_2 in dry air, Pb is the barometric pressure and Pw is the equilibrium water vapor pressure at sea surface temperature and salinity. The following empirical expression was used to compute the equilibrium water vapor pressure, Pw:

$$Pw\ (mm\ Hg) = [1 - 5.3684 \times 10^{-4} \cdot (Sal - 0.03)] \cdot EXP\{[0.0039476 - (1/TK)]/1.8752 \times 10^{-4}\} \quad \ldots\ldots(3)$$

where Sal is salinity in o/oo, and TK is the temperature in °K. The sea-air pCO_2 difference values have been computed as defined below, and are listed in the data table:

$$D\ pCO_2\ (uatm) = (pCO_2)_{sw} - (pCO_2)_{air} \quad \ldots\ldots(4)$$

2) Determination of the Total CO_2 Concentration in Seawater:

For the determination of the total CO_2 concentration in seawater, a coulometer is used. Our coulometer system is similar to that described by Johnson et al (1985), and has been modified from a commercial coulometer

Table 1 Concentrations of CO_2 in marine air observed during the CONFLUENCE-2 Expedition in September, 1989. The Vco_2 values represent the mole fraction of CO_2 in dry air.

Station No.	Iat.(S) Degrees	Long.(W) Degrees	Date	Time (GMT)	VCO2 (ppm)
0.03	39.095	60.562	9/03/89	2102	351.9
					352.3
3	37.828	52.228	9/05/89	1915	353.6
					352.1
10	35.308	48.018	9/08/89	1200	351.7
					352.2
20	36.703	52.988	9/11/89	0433	352.4
					353.4
25	39.115	54.248	9/13/89	0000	352.1
					351.4
				Mean	352.3
				(N = 10)	± 0.7

(Model-5011) manufactured by the Coulometrics Inc. (Golden. CO). It consists of a CO_2 extraction vessel, a CO_2 absorber cell, and a coulometer. A known volume of a seawater sample (about 25 ml containing about 50 micro-moles of CO_2) is forced into the extraction vessel by a CO_2-free nitrogen gas, and is acidified using 1 ml of 10% phosphoric acid. The liberated CO_2 gas is swept by a stream of nitrogen gas into the CO_2 absorber cell, which is filled with an aqueous solution of dimethylsulfoxide, monoethanolamine, and thymolphthalein. The CO_2 is absorbed quantitatively by this solution, in which it reacts with the monoethanolamine to form hydroxyethylcarbamic acid and lower the pH, thus causing a color change in the thymolphthalein indicator from blue to colorless. The photocell in the coulometer detects the color change, and instructs the unit to pass an electric current through the cell, so that the water in the solution dissociates to generate OH^- ions and hydrogen gas. The OH^- ions neutralize the acid until the original pH is restored in the CO_2 absorber solution. The product of current passed and time represents the amount of CO_2 released from the sea water sample. The entire procedure takes about 7 minutes. We calibrated the coulometer system using five independent methods: 1) gravimetrically prepared $CaCO_3$ standards, 2) gravimetrically prepared Na_2CO_3 standards, 3) volumetrically prepared pure (99.999%) CO_2 gas standards, 4) WMO air-CO_2 gas mixture standards, and 5) a calibrated electrical current meter. We have found that the results of these calibrations agree within 0.1%.

The water samples for the total CO_2 determination were collected in 500 ml Pyrex bottles and were spiked immediately after collections with 250 micro-liters of saturated mercuric chloride solutions in order to prevent biological alterations of sample during storage. Many of the samples were analyzed at sea during the expedition, while some of them were stored for shore-based determinations. Those intended for shore-based study were stored in the 500 ml Pyrex bottles washed with chromic acid prior to the expedition in order to remove organic coatings. After the mercuric chloride spike was added, the bottles were sealed using ground glass stoppers, and a small air space was left in each sample in order to allow space for thermal expansion of water. The purpose of the stored samples is to determine their total CO_2 concentrations more precisely under stable land-based laboratory conditions. No systematic difference has been found between the results of ship board measurements and those obtained in our land-based laboratories. Based upon the results obtained for deep water samples collected below 2000 meters, the precision of the total CO_2 values reported here has been estimated to be about ± 2 uM/kg.

GRAPHICAL PRESENTATION OF THE DATA,

CONFLUENCE-2, SEPTEMBER 4-13, 1989

(11 Figures)

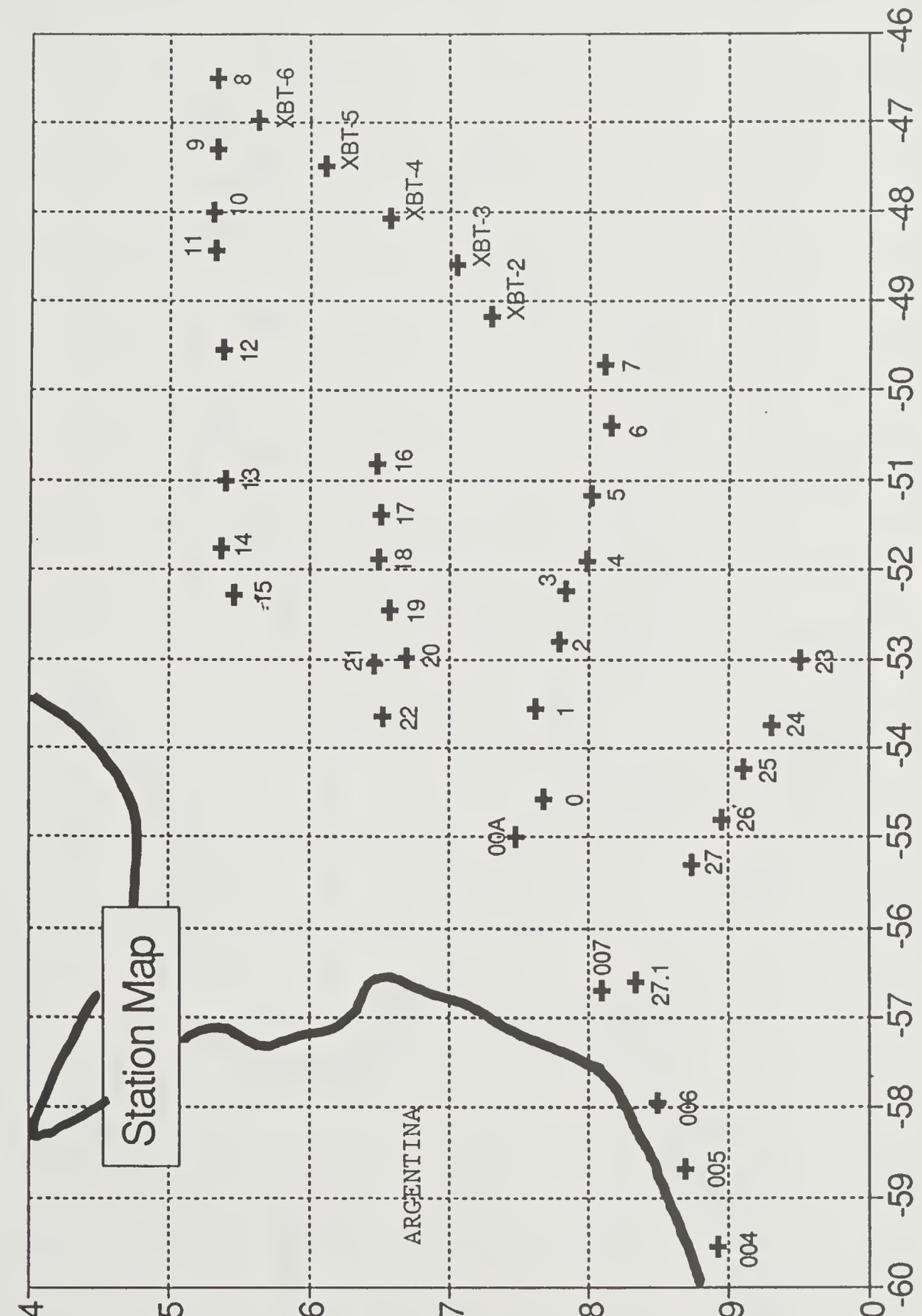


Fig. 1 Station locations and designations, Confluence-2, September 4-13, 1989.

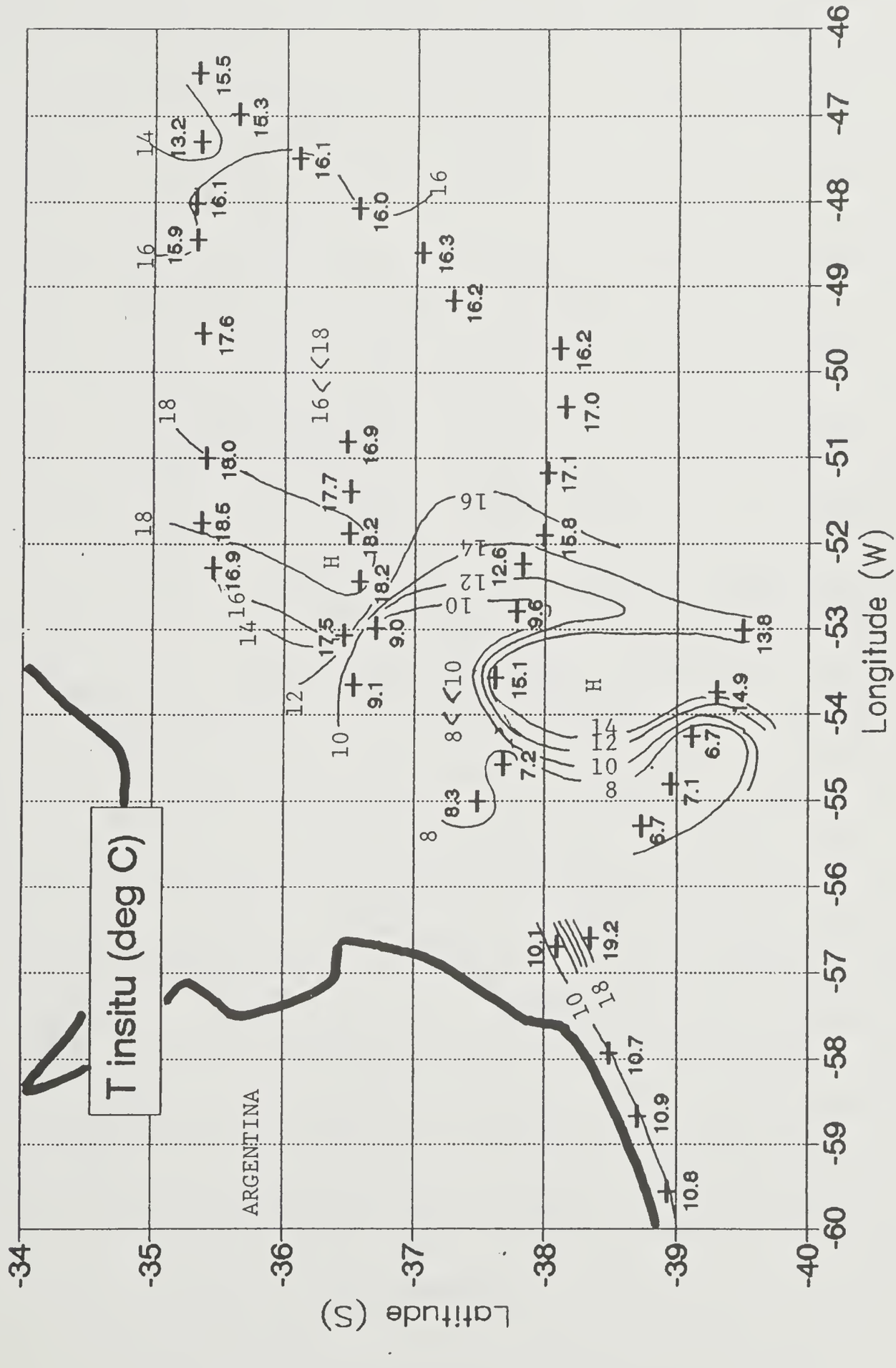
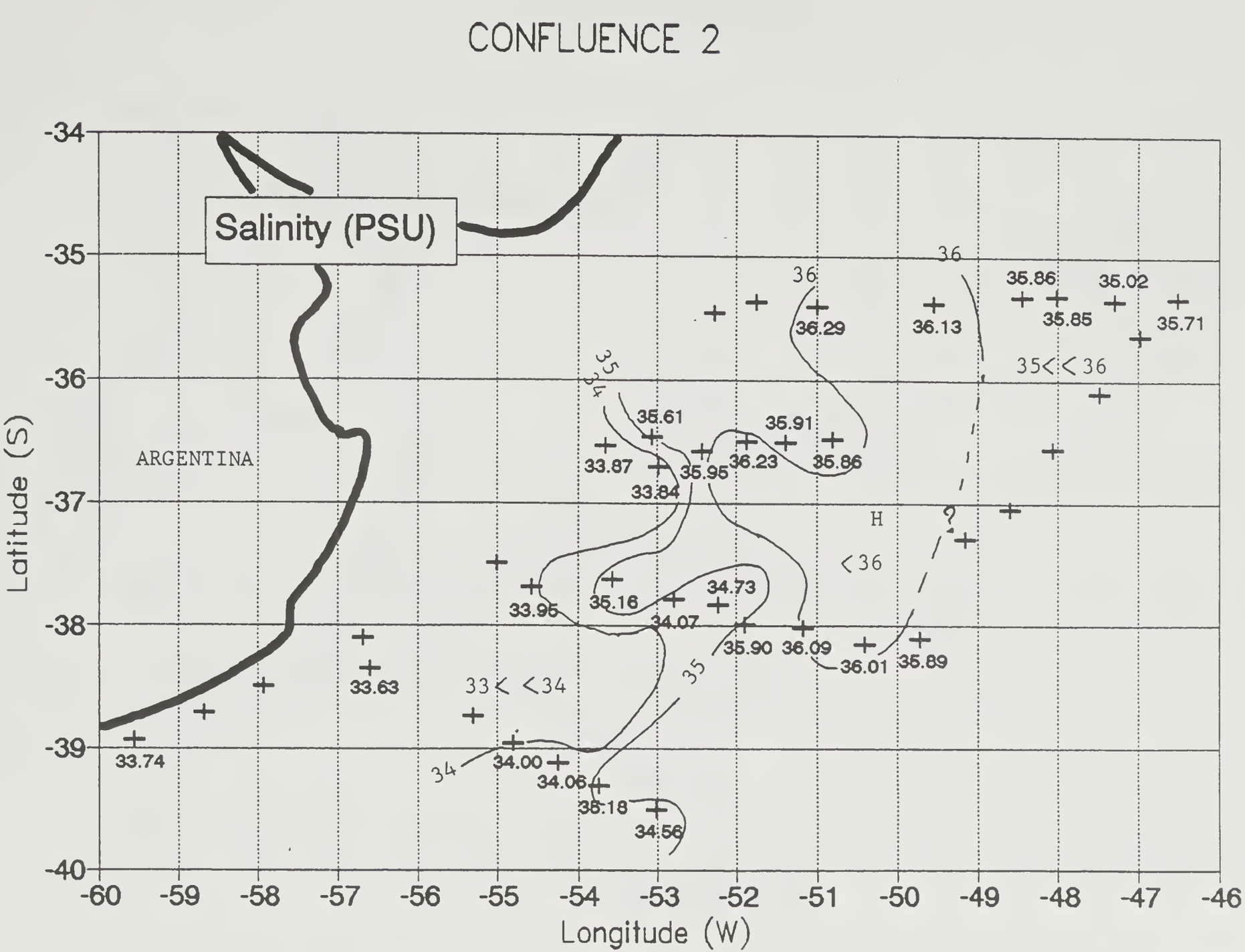


Fig. 2 Distribution of surface water temperature (^{o}C) during Confluence-2, September 4 - 13, 1989.

Fig. 3 Distribution of the surface water salinity (o/oo) during Confluence-2, September 4-13, 1989.



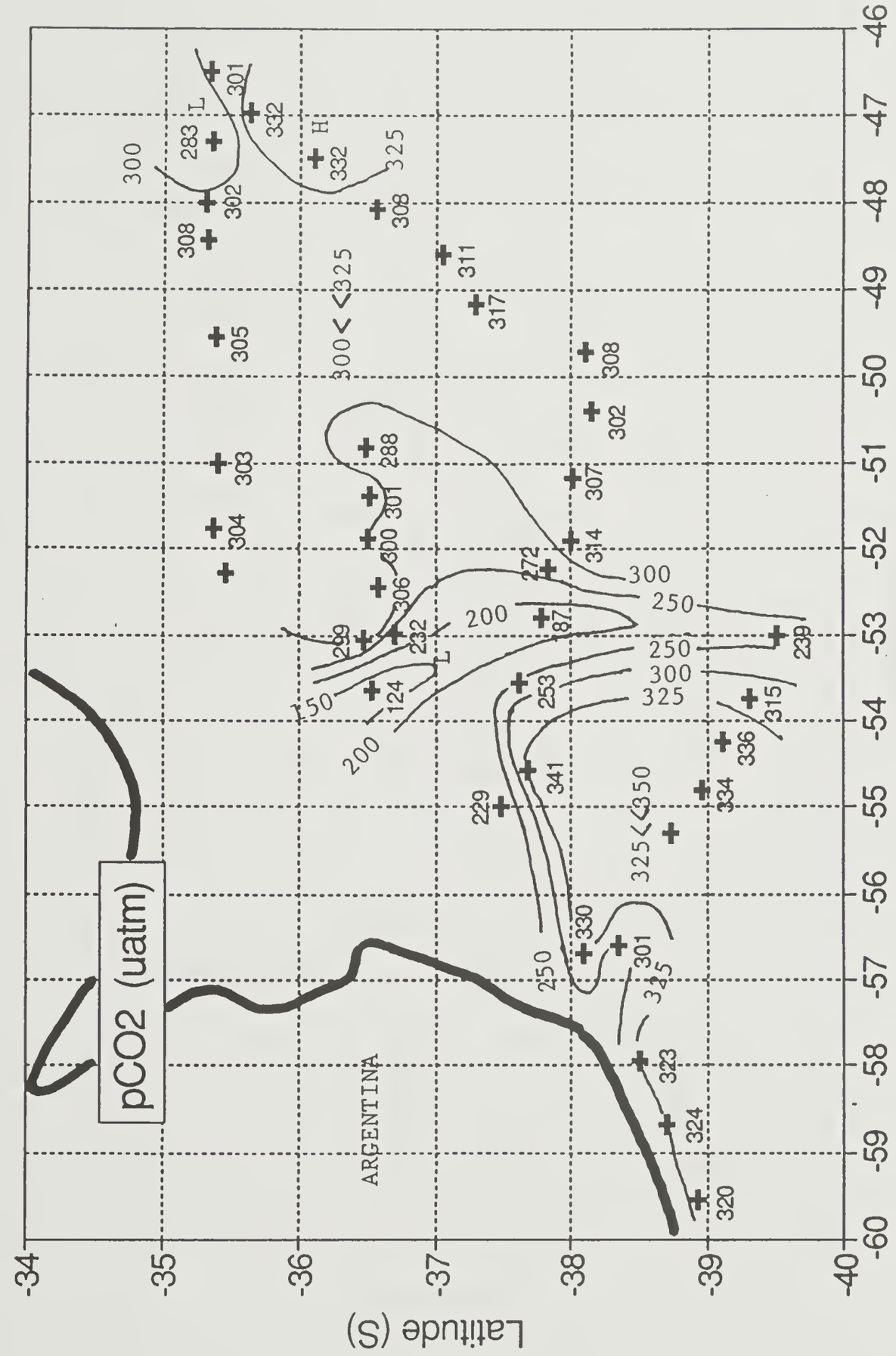


Fig. 4 Distribution of surface water pCO_2 (uatm) observed during Confluence-2, September 4-13, 1989.

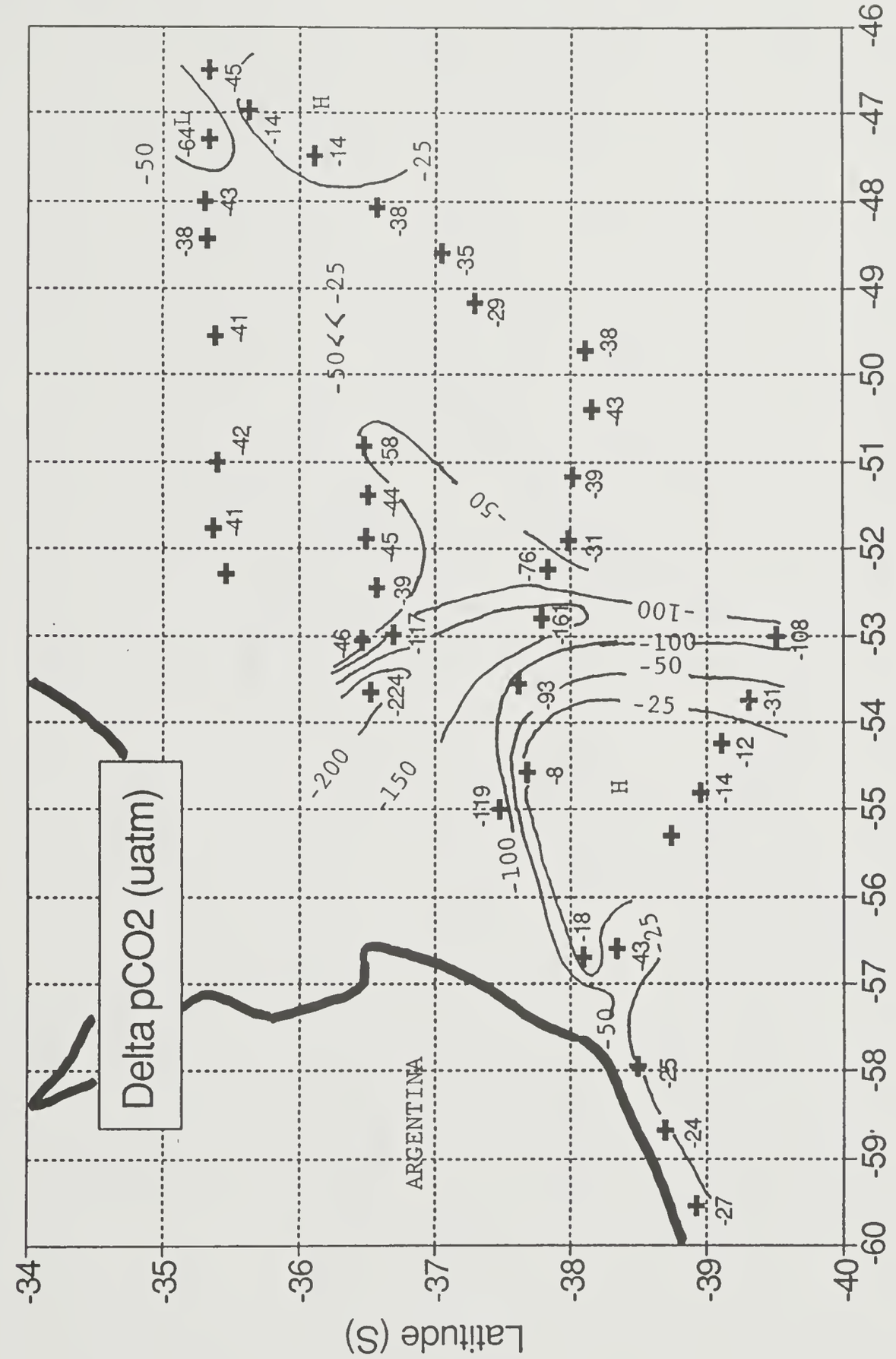


Fig. 5 Distribution of sea-air pCO_2 difference (µatm) observed during Confluence 2, September 4-13, 1989.

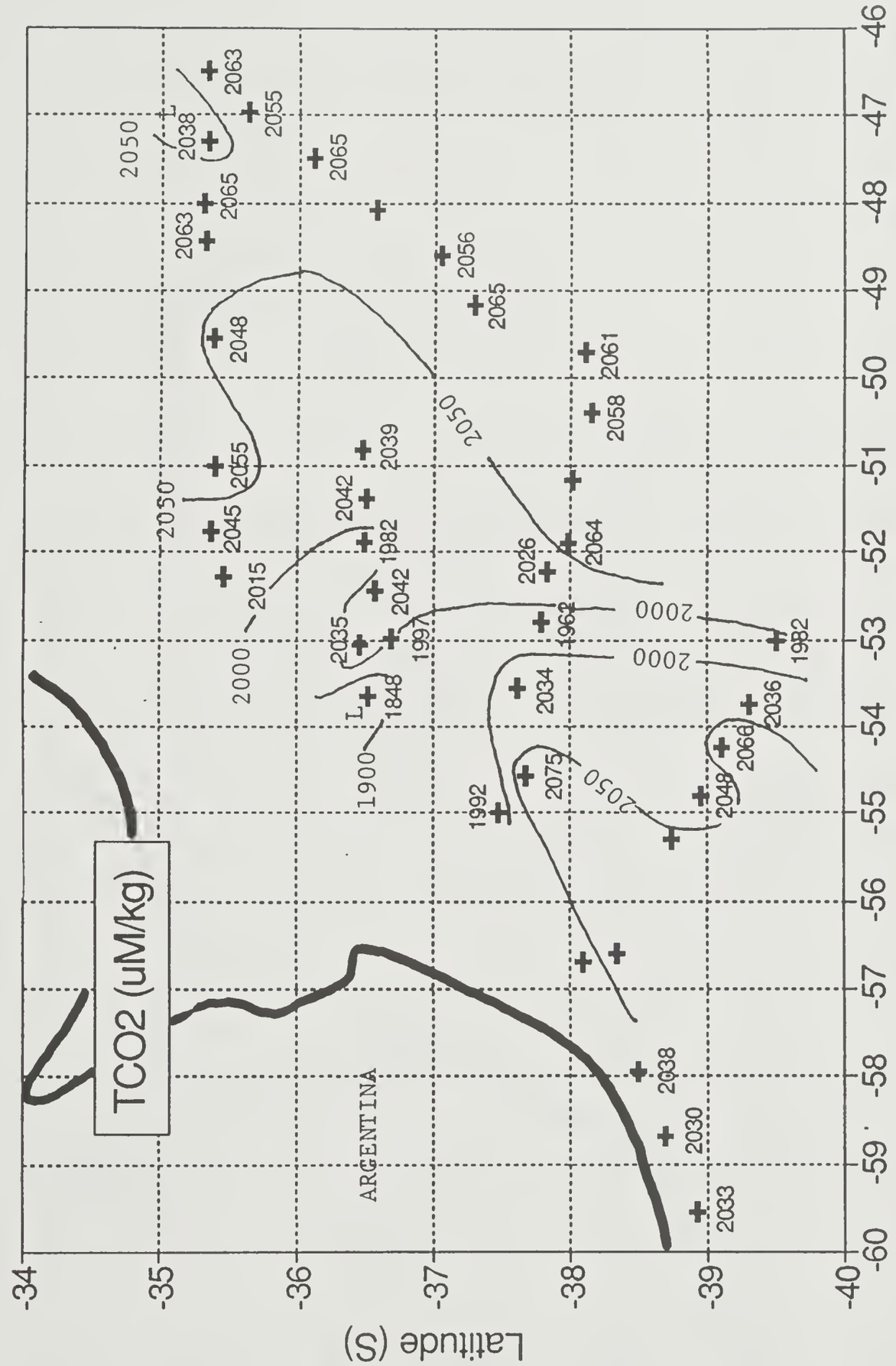


Fig. 6 Distribution of the total CO_2 concentration in surface water observed during Confluence-2, September 4-13, 1989.

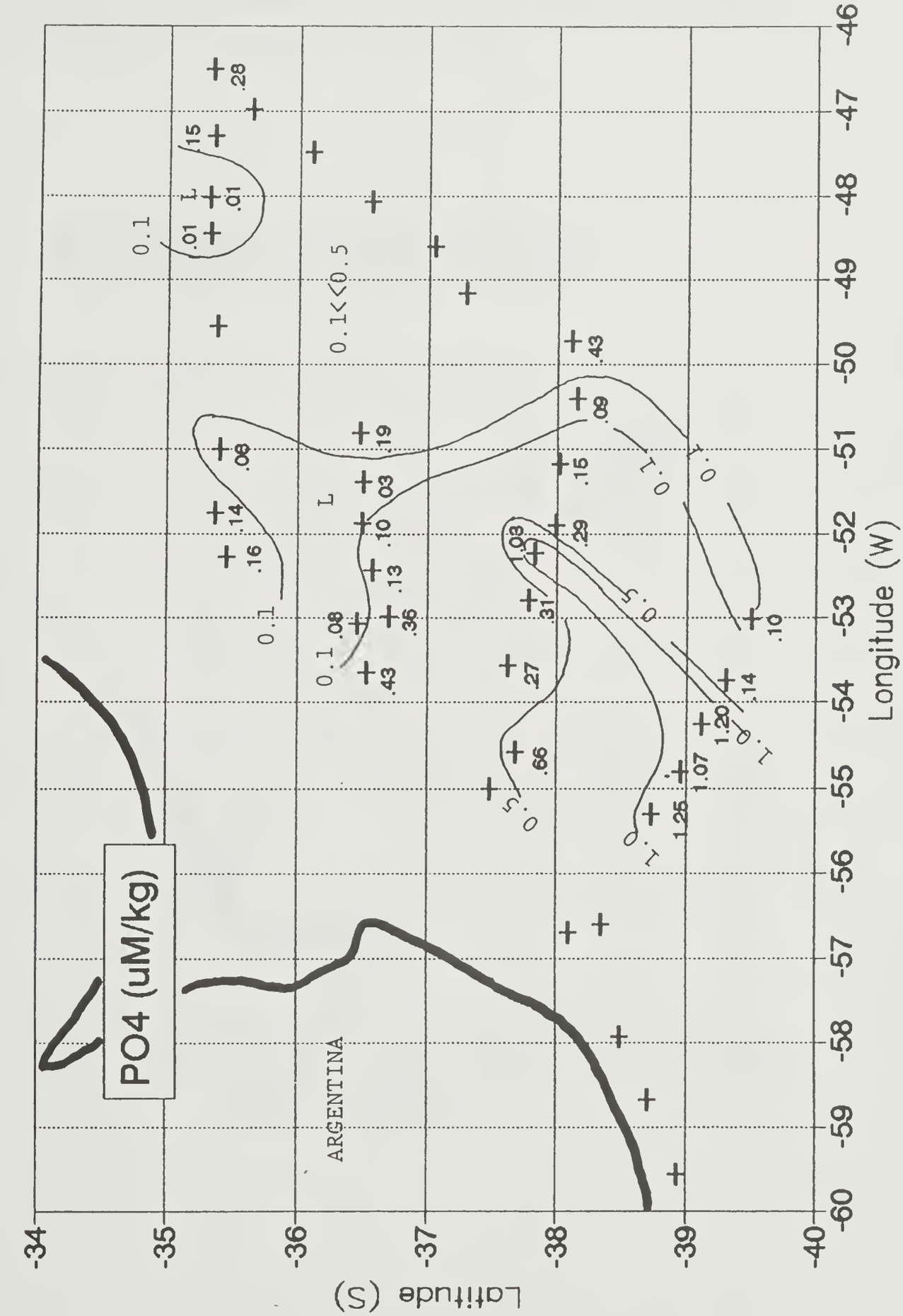


Fig. 7 Distribution of phosphate (uM/kg) in surface water observed during Confluence-2, September 4-13, 1989.

Fig. 8 Potential temperature versus salinity observed during Confluence 2, September 4-13, 1989.

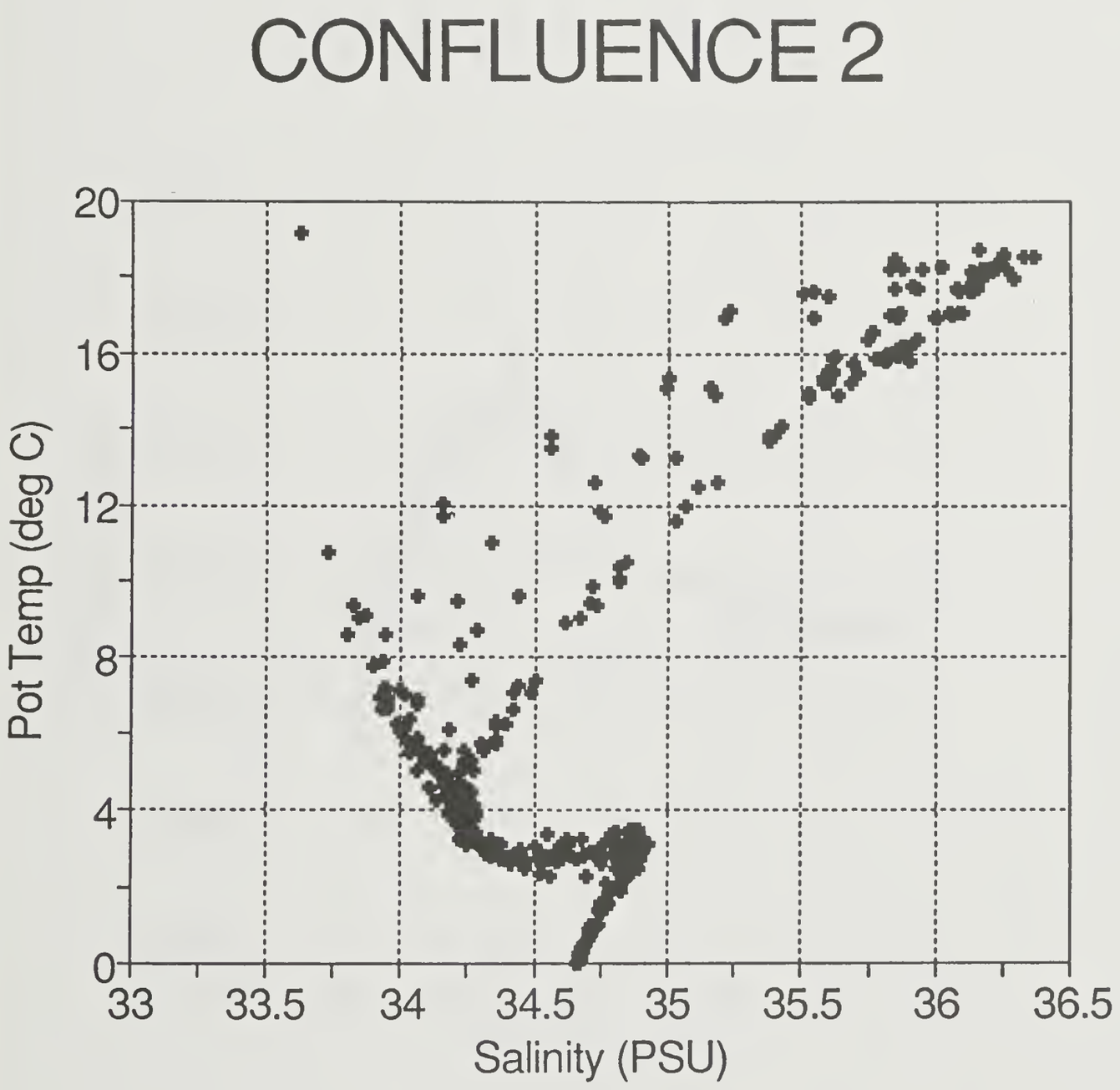


Fig. 9 Total CO_2 concentration versus salinity observed during Confluence-2, September 4-13, 1989.

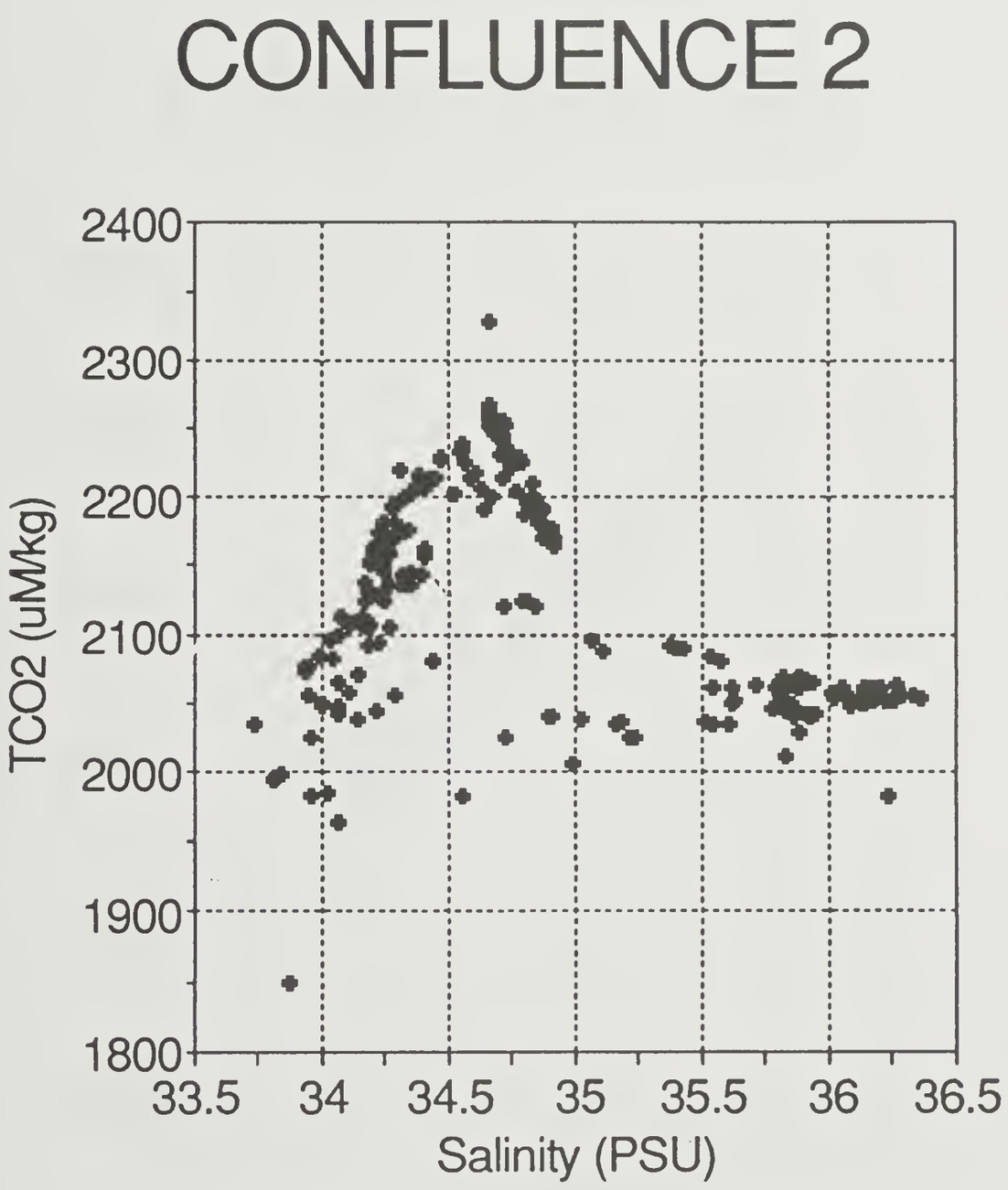


Fig. 10 Total CO_2 concentration versus Apparent Oxygen Utilization observed during Confluence-2, September 4-13, 1989.

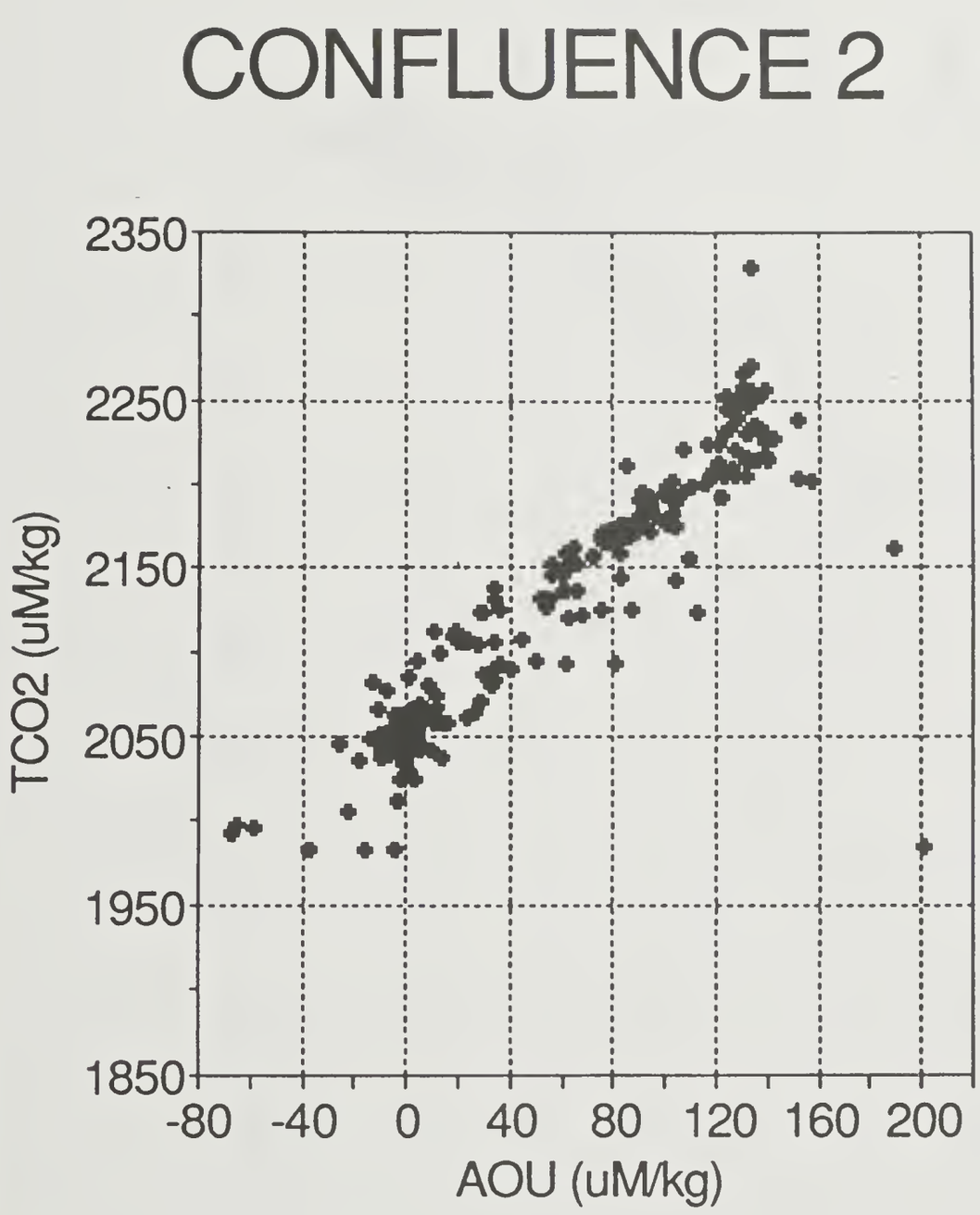
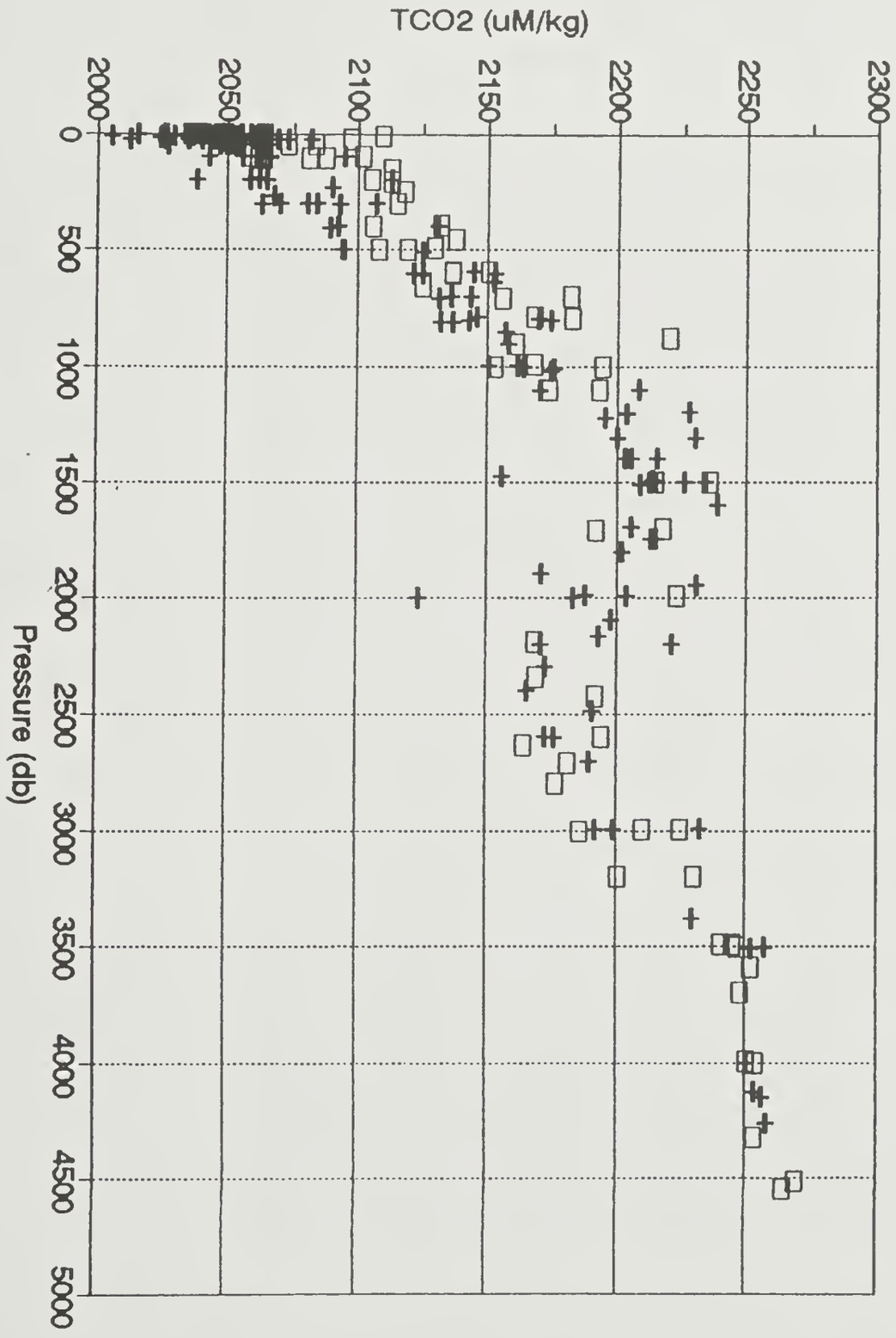


Fig. 11 Vertical distribution of the total CO_2 concentration observed during Confluence-2, September 4-13, 1989. The plus singns indicate the measurements made at sea, and the open square signs indicate those made on land for stored (poisoned) water samples.



DATA TABLES FOR THE CONFLUENCE-2 EXPEDITION

Definition of the Quantities:

Among the quantities listed, the following quantities have been measured or calculated by the authors of this report; TCO2 (SHIP and LAB), pCO2(sw), pCO2(air), D pCO2, TALK and AOU. All other quantities listed in this report have been measured by the Argentine and French groups and transmitted to us by Drs. Alberto Piola, Veronique Garcon and Christine Provost.

Pres (dbar)	= Pressure in decibars. "0" means sea surface.
T insit (deg C)	= Temperature (°C) at the <u>in situ</u> condition.
Theta (deg C)	= Potential temperature (°C).
Sal (PSU)	= Salinity (o/oo) in the practical salinity unit.
O2 (uM/kg)	= Oxygen concentration dissolved in seawater. The originally reported values in ml STP/liter have been converted to uM/kg using the molar volume of oxygen gas at STP of 22.385 liter/mol and the density of seawater computed for 1 atm. and potential temperature using the International Equation of State for Seawater.
AOU (uM/kg)	= The measured value (above) minus the atmospheric saturation value at the potential temperature. The latter quantity has been computed using the following formula based upon the experimental data of Murray and Riley (1969): $\ln(O_2 \text{ in uM/kg}) = -173.9894 + 255.5907(100/TK) + 146.4813.\ln(TK/100) - 22.2040(TK/100) + Sal[-0.037362 + 0.016504(TK/100) - 0.0020564(TK/100)^2]$, where TK is temperature in °K and Sal is salinity in o/oo.
SiO2 (uM/kg)	= The concentration of total dissolved silica.
PO4 (uM/kg)	= The concentration of dissolved phosphate.
NO3 (uM/kg)	= The concentration of dissolved nitrate in seawater. The concentrations of these three nutrient salts have been determined colorimetrically, and the original per liter values have been converted using the seawater density at the assumed laboratory temperature of 25°C.

TCO2 (uM/kg) --SHIP-- = The total CO_2 concentration of all CO_2 species dissolved in seawater. This has been measured at sea using a coulometer as described in the text.

TCO2 (uM/kg) --LAB-- = The total CO_2 concentration of all CO_2 species dissolved in seawater. This has been measured in our land-based laboratories at Lamont for the stored (poisoned with mercuric chloride) seawater samples.

pCO2(sw) (uatm) = The partial pressure of CO_2 in seawater at the in situ temperature. The method of measurement is described in the text.

pCO2(air) (uatm) = The partial pressure of CO_2 in the marine air at the sea surface. The methods of measurements and computation are described in the text. See Equations (2) and (3) and Table 1.

D pCO2(sw-air) (uatm) = The difference between pCO_2 in surface seawater and that in overlying air. See the text and Equation (4).

TALK (ueq/kg) = The total alkalinity in seawater computed using the measured temperature, salinity, pCO_2 and the concentrations of SiO_2, PO_4, and TCO_2, The method of computation have been described in Peng et al. (1987). A copy of the computer program is attached in Appendix 1.

pH = The seawater pH values, which have been provided to us. The pH scale used and the temperature of measurements are not specified.

CONFLUENCE 2 -- September 1989 -- Western South Atlantic Report Date: 09/17/90

Sta 0.04		Position	38.933S	59.550W		Depth =			Date =	9/04/89		Time =	0030Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	10.75	10.750	33.735						2033		320	347.6	-27		

Sta 0.05		Position	38.708S	58.666W		Depth =			Date =	9/04/89		Time =	0348Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	10.9								2030		324	348.0	-24		

Sta 0.06		Position	38.495S	57.928W		Depth =			Date =	9/04/89		Time =	0647Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	10.66								2038		323	348.0	-25		

Sta 0.07		Position	38.093S	56.703W		Depth =			Date =	9/04/89		Time =	1145Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	10.08										330	348.0	-18		

Sta 00A		Position	37.483S	55.007W		Depth =			Date =	9/04/89		Time =	1938Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	8.30								1992		229	348.0	-119		

CONFLUENCE 2 -- September 1989 -- Western South Atlantic Report Date: 09/17/90

Station 0 Position 37.683S 54.585W Depth = 815 m Date = 9/04/89 Time = 2229Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	7.2	7.200	33.949			8.04	0.66	2.50	2075		341	348.5	-8	2256	8.03
2	10	6.918	6.917	33.942	304.6	-7.7	10.59	1.44	17.70	2077						8.02
3	10															
4	20	6.221	6.219	33.989	300.2	1.4	10.80	1.48	19.10	2085						8.01
5	20															
6	50															
7	51	5.852	5.848	34.067	291.5	12.7	11.65	1.59	20.81	2100						8.00
8	101	5.604	5.596	34.078	295.8	10.1	11.86	1.60	21.13	2113						8.00
9	152	5.463	5.451	34.112	287.1	19.8	12.80	1.61	22.11	2106						8.00
10	203	5.219	5.203	34.126	291.5	17.3	12.71	1.63	22.35	2110						8.00
11	304	5.021	4.997	34.156	287.1	23.1	14.82	1.70	23.25	2108						8.00
12	412	4.915	4.883	34.171	282.7	28.3	16.51	1.71	23.24	2123						8.00
13	506	4.721	4.682	34.171	282.7	29.8	17.57	1.87	24.92	2123						8.00
14	607	4.413	4.367	34.176	278.4	36.5	24.81	1.90	25.14	2125						8.00
15	704	4.014	3.963	34.208	256.6	61.3	34.34	2.12	27.50	2157						7.95
16	770	3.745	3.690	34.240	243.5	76.5	39.62	2.19	29.50	2171						7.90

Station 1 Position 37.627S 53.570W Depth = 2800 m Date = 9/05/89 Time = 0330Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	15.124	15.124	35.162			5.21	0.27	0.31	2034		253	346.2	-93	2357	8.32
2	10	15.074					7.48	0.66	4.84							
3	12	15.086	15.084	34.995	270.0	-22.6	7.57	0.16	0.08	2005						
4	20	11.640					19.88	0.95	4.19							
5	24	8.554	8.552	33.946	291.6	-5.6	25.38	0.83	8.88	2055						
6	25	7.891	7.889	33.937	278.5	11.8	34.53	1.03	12.80	2073						
7	50															
8	646	4.306	4.258	34.250	252.3	63.3	33.04	1.83	27.37	2152						
9	805	3.803	3.745	34.277	239.2	80.3	49.49	1.99	29.87	2170						
10	1036	2.947	2.877	34.322	221.8	104.6	58.33	2.18	32.06	2175						
11	1115	2.801	2.726	34.371	208.7	118.7	58.32	2.24	33.08	2208						
12	1326	2.662	2.572	34.467	195.6	132.8	72.14	2.29	33.94	2230						
13	1519	2.717	2.611	34.537	191.3	136.7	77.25	2.24	33.15	2234						
14	1766	3.066	2.934	34.718	204.3	120.6	65.79	1.96	29.31	2213						
15	1995	3.264	3.108	34.842												
16	2191	2.976	2.807	34.842	226.0	99.6	56.76	1.63	24.09	2193						

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Station 2 Position 37.783S 52.793W Depth = 3500 m Date = 9/05/89 Time = 1325Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	9.624	9.624	34.065			6.26	0.31	0.17	1962		187	347.9	-161	2276	
2	10	9.484	9.483	34.216	304.7	-25.1	4.91	0.70	6.36	2044						8.10
3	20	8.754	8.752	34.286	287.2	-3.2	6.65	0.80	8.07	2055						8.05
4	50															
5	99	5.813	5.805	34.032	300.2	4.3	8.18	1.46	19.64	2095						7.95
6	204	5.570	5.553	34.164	287.1	19.0	24.19	1.43	21.05	2113						8.00
7	403	4.771	4.740	34.185	278.4	33.7	31.67	1.63	24.17	2131						7.90
8	607	4.094	4.050	34.197	261.0	56.3	25.17	1.84	26.90	2153						7.92
9	810	3.963	3.903	34.288	226.1	92.1	42.90	1.99	29.48	2174						7.85
10	1024	3.305	3.233	34.337	221.8	101.6	49.08	2.08	30.88	2176						7.80
11	1516	2.877	2.769	34.564	186.9	139.7	73.41	2.25	31.74	2226						7.82
12	2029	3.528	3.365	34.864	230.4	90.7	49.17	1.59	23.37	2183						7.82
13	2325	3.245	3.058	34.903	243.4	80.1	47.28	1.45	21.57	2173						7.95
14	2734	2.558	2.344	34.859	239.0	90.4	60.02	1.59	23.37	2190						7.89
15	3027	1.557	1.336	34.752	213.0	125.3	107.89	2.02	28.61	2232						7.80
16	3553	0.606	0.357	34.684	213.0	134.2	114.59	2.30	31.57	2252						7.75

Station 3 Position 37.828S 52.228W Depth = 3700 m Date = 9/05/89 Time = 1915Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	12.584	12.584	34.725			7.77	1.03	13.98	2026		272	347.8	-76	2300	8.20
2	10	12.014	12.013	34.153	296.1	-31.2	7.03	0.37	2.09							8.17
3	20	11.684	11.681	34.161	296.1	-29.3	7.77	0.93	8.28							8.15
4	50															
5	99	8.304	8.294	34.219	278.5	8.6	9.80	1.44	21.82							
6	203	6.136	6.119	34.188	278.4	23.5	15.10	1.70	26.25							
7	399	5.571	5.538	34.311	243.6	62.3	19.18	1.82	28.06							
8	584	4.263	4.220	34.205	265.3	50.6	27.09	1.91	29.57							
9	809	3.843	3.784	34.211	256.6	62.7	33.81	2.01	30.20							
10	1107	3.264	3.186	34.271	239.2	84.8	57.69	2.05	31.79							
11	1519	3.046	2.936	34.523	195.6	129.7	51.63	2.19	32.89							
12	1914	2.923	2.780	34.692	195.6	130.6	57.87	2.06	31.61							
13	2327	3.157	2.972	34.868	230.4	93.9	41.96	1.57	23.85							
14	2693	2.929	2.711	34.905	252.1	74.2	35.84	1.38	21.72							
15	3133	1.724	1.489	34.776												
16	3524	0.944	0.689	34.708	213.0	131.2		2.13	31.60							

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Station 4 Position 37.992S 51.888W Depth = 4846 m Date = 9/06/89 Time = 0135Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	15.774	15.774	35.903			3.73	0.29	1.27	2064		314	345.9	-31	2351	8.38
2	10	15.894	15.892	35.614	252.5	-10.1	3.09	0.14	0.68	2050						8.39
3	20	15.904	15.901	35.627	248.1	-5.8	3.09	0.13	0.76	2051						8.37
4	50															
5	103	16.064	16.048	35.874	239.4	1.8	3.09	0.17	1.12	2066						8.32
6	311	13.726	13.681	35.375	217.6	36.1	5.64	0.56	7.72	2092						8.27
7	605	6.365	6.310	34.353	243.6	56.6	13.84	1.54	22.12	2145						8.11
8	801	4.718	4.654	34.243	252.3	60.3	16.60	1.74	25.22	2146						8.09
9	990	3.946	3.872	34.241	247.9	70.7	28.11	1.91	27.65							8.06
10	1514	2.808	2.702	34.448	195.7	131.8	52.77	2.14	30.82	2213						7.98
11	2021	3.262	3.104	34.763	200.0	123.5	48.94	1.79	26.42	2204						8.02
12	2629	3.156	2.940	34.901	239.1	85.4	38.08	1.39	21.72	2176						8.03
13	3032	2.430	2.189	34.843	230.4	100.4	58.50	1.61	23.92	2199						7.99
14	3544	1.100	0.839	34.716	208.6	134.1	101.81	2.08	31.11	2257						8.01
15	4050	0.311	0.021	34.667	221.7	128.7	112.38	2.16	30.96	2250						7.98
16	4307	0.160	-0.152	34.660	221.7	130.3	123.72	2.24	31.56	2258						7.99

Station 5 Position 38.012S 51.182W Depth = 4800 m Date = 9/06/89 Time = 0832Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.054	17.054	36.094	235.0	1.2	1.09	0.15	0.43			307	345.4	-39		
2	10	17.064	17.062	36.053	235.0	1.2	0.78	0.08	0.33							
3	20	17.054	17.051	36.052	230.7	5.6	1.69	0.09	0.33							
4	50															
5	114	17.032	17.013	36.088	230.7	5.7	0.48	0.04	0.43							
6	350	15.249	15.195	35.682	222.0	23.7	1.09	0.29	3.67							
7	605	9.472	9.403	34.710	208.8	70.3	9.43	1.23	18.42							
8	814	5.366	5.297	34.268	256.6	51.1	12.77	1.62	24.37							
9	1010	4.148	4.071	34.203	261.0	56.2	23.08	1.80	27.17							
10	1514	2.886	2.779	34.392	208.7	118.3	42.54	1.94	28.87							
11	2026	2.993	2.839	34.691	186.9	138.8	61.39	2.02	30.77							
12	2628	2.823	2.614	34.819	208.6	118.6	57.43	1.72	26.87							
13	3034	2.722	2.474	34.863	226.0	102.3	50.13	1.54	24.58							
14	3532	1.894	1.614	34.787	213.0	122.8	78.70	1.85	27.92							
15	4035	0.915	0.609	34.710	213.0	131.9	101.81	2.11	31.62							
16	4754	0.206	-0.156	34.666	221.7	130.3	123.10	2.24	33.58							

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Station 6 Position 38.148S 50.402W Depth = 4931 m Date = 9/06/89 Time = 1604Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.954	16.954	36.008	230.7	6.1	1.46	0.09	0.53	2058		302	345.4	-43	2367	8.32
2	10	16.944	16.942	35.998	230.7	6.2	1.46	0.10	0.53							
3	20	16.954	16.951	35.992	226.3	10.5	0.92	0.09	0.53							
4	50															
5	98	16.999	16.983	36.058	230.7	5.9	1.18	0.09	0.58	2062						8.41
6	204	16.360	16.327	35.935	213.3	26.5	2.00	0.16	1.53	2065						8.35
7	409	13.846	13.787	35.394	213.2	39.9	2.54	0.54	8.02	2089						8.29
8	710	6.258	6.194	34.354	239.2	61.8	12.71	1.58	24.42	2136						8.12
9	1004	4.240	4.163	34.281	230.5	85.7	26.51	1.88	29.37		2168					8.12
10	1491	2.898	2.793	34.403	217.4	109.4	31.36	1.64	25.37	2156						8.11
11	2023	3.504	3.342	34.790	208.7	112.8	42.97	1.76	28.06	2123						8.05
12	2518	3.102	2.899	34.859	221.7	103.2	45.94	1.58	25.65	2191						8.08
13	3032	2.657	2.411	34.866	234.7	94.1	50.53	1.52	24.88	2192						8.10
14	3417	1.820	1.554	34.776	213.0	123.4	82.40	1.90	29.87	2229						8.06
15	3800	1.164	0.875	34.722												8.39
16	4196	0.630	0.315	34.689	208.6	139.0	113.18	2.17	33.61	2256						8.01

Station 7 Position 38.107S 49.712W Depth = 5000 m Date = 9/07/89 Time = 0045Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.186	16.186	35.885	235.0	5.5	1.95	0.43	1.68	2061		308	345.8	-38	2356	8.35
2	10	16.184	16.182	35.885	230.7	9.9	1.73	0.37	1.27	2060						8.41
3	20	16.184	16.181	35.879	235.0	5.6	1.73	0.37	1.47	2069						8.03
4	50															
5	103	16.184	16.167	35.906	235.0	5.6	1.73	0.36	1.07	2066						8.42
6	269	15.862	15.819	35.822	230.7	11.7	4.03	0.39	1.68	2068						8.41
7	663	5.597	5.541	34.237	252.3	53.7	14.94	1.82	23.35		2125					8.17
8	1018	3.744	3.669	34.213	239.2	81.0	31.14	2.19	27.93	2164						8.17
9	1414	2.809	2.711	34.388	195.7	131.9	58.69	2.60	32.63	2216						8.05
10	1765	2.786	2.658	34.589	186.9	140.5	64.43	2.41	30.36	2214						8.07
11	2224	2.808	2.639	34.750	200.0	127.3	67.86	2.18	28.70	2221						8.07
12	2736	2.822	2.602	34.853	230.4	96.9	51.21	1.78	23.23		2181					8.10
13	3232	1.840	1.592	34.757	204.3	131.8	88.51	2.21	28.69		2230					8.07
14	3635	1.296	1.021	34.724	204.3	136.8	104.59	2.38	30.55		2252					8.05
15	4039	0.799	0.496	34.696	213.0	132.9	113.20	2.49	31.62		2250					8.03
16	4563	0.237	-0.105	34.665	217.3	134.2	134.14	2.70	32.82		2269					8.03

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XBT 2 Sample ID	Pres (dbar)	Position T insit (deg C)	37.283S Theta (deg C)	49.152W Sal (PSU)	O2 (uM/kg)	Depth = AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/07/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	0505Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.2									2065	317	346.0	-29		

XBT 3 Sample ID	Pres (dbar)	Position T insit (deg C)	37.050S Theta (deg C)	48.583W Sal (PSU)	O2 (uM/kg)	Depth = AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/07/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	0801Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.25									2056	311	346.0	-35		

XBT 4 Sample ID	Pres (dbar)	Position T insit (deg C)	36.567S Theta (deg C)	48.071W Sal (PSU)	O2 (uM/kg)	Depth = AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/07/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	1100Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.0										308	346.0	-38		

XBT 5 Sample ID	Pres (dbar)	Position T insit (deg C)	36.107S Theta (deg C)	47.483W Sal (PSU)	O2 (uM/kg)	Depth = AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/07/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	1355Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.05									2065	332	346.0	-14		

XBT 6 Sample ID	Pres (dbar)	Position T insit (deg C)	35.632S Theta (deg C)	46.978W Sal (PSU)	O2 (uM/kg)	Depth = AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/07/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	1700Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	15.27									2055	332	346.0	-14		

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XBT 2		Position	37.283S	49.152W		Depth =			Date =	9/07/89		Time =	0505Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.2									2065	317	346.0	-29		

XBT 3		Position	37.050S	48.583W		Depth =			Date =	9/07/89		Time =	0801Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.25									2056	311	346.0	-35		

XBT 4		Position	36.567S	48.071W		Depth =			Date =	9/07/89		Time =	1100Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.0										308	346.0	-38		

XBT 5		Position	36.107S	47.483W		Depth =			Date =	9/07/89		Time =	1355Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.05									2065	332	346.0	-14		

XBT 6		Position	35.632S	46.978W		Depth =			Date =	9/07/89		Time =	1700Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	15.27									2055	332	346.0	-14		

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Station 8 Position 35.330S 46.500W Depth = 4824 m Date = 9/07/89 Time = 1950Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	15.504	15.504	35.712	248.1	-4.0	3.45	0.28	0.65	2063		301	346.0	-45	2356	8.32
2	10	15.544	15.542	35.601	248.1	-4.0	2.88	0.41	0.44							
3	20	15.534	15.531	35.617	248.1	-4.0	2.59	0.43	0.61							
4	50															
5	103	15.490	15.474	35.617	243.7	0.6	2.59	0.49	0.84	2062						8.40
6	231	14.125	14.091	35.427	217.6	33.9	3.74	0.84	6.43	2090						8.32
7	600	5.724	5.673	34.317	239.2	65.6	17.80	2.13	25.23		2136					8.11
8	864	3.722	3.660	34.210	247.9	72.4	32.28	2.45	29.13	2157						8.12
9	1216	2.905	2.822	34.354	208.7	118.0	53.82	2.56	32.52	2203						8.02
10	1728	2.916	2.790	34.646	204.3	121.9	50.64	2.13	27.32		2192					8.10
11	2220	3.449	3.269	34.910	243.4	78.3	34.86	1.63	21.48		2168					8.12
12	2632	2.878	2.668	34.864	234.7	92.0	50.64	1.78	23.50		2194					8.11
13	3035	2.526	2.282	34.857	234.7	95.2	54.08	1.80	23.74		2187					8.10
14	3532	1.270	1.006	34.719	213.0	128.3	108.03	2.41	30.76		2240					8.02
15	4051	0.467	0.172	34.671	217.3	131.6	119.51	2.49	31.79		2254					8.02
16	4596	0.207	-0.138	34.661	221.7	130.2	129.27	2.56	32.61		2264					8.00

Station 9 Position 35.342S 47.293W Depth = 4502 m Date = 9/08/89 Time =

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	13.244	13.244	35.024	265.5	-8.9	2.89	0.15	1.14	2038		283	346.8	-64	2312	8.36
2	10	13.274	13.273	34.901	265.5	-8.8	5.18	0.30	1.54	2039						
3	20	13.304	13.301	34.893	265.5	-9.0	7.19	0.30	1.63	2040						8.33
4	50						9.84	0.28	1.83							
5	101	11.755	11.742	34.762	252.4	12.8	10.94	0.66	7.44							
6	264	7.262	7.237	34.437	265.4	28.3	14.38	1.67	22.73							
7	506	4.498	4.460	34.199	265.3	48.8	17.84	1.97	26.24							
8	808	3.387	3.331	34.234	243.5	79.3	35.21	2.31	30.87							
9	1019	2.969	2.900	34.321	243.5	82.6	49.01	2.48	32.98							
10	1521	2.937	2.828	34.617	217.4	108.7	56.77	2.38	31.91							
11	2020	2.972	2.819	34.797	208.6	117.0	61.07	2.05	27.78							
12	2720	2.520	2.308	34.852	230.4	99.4	58.19	1.82	25.15							
13	3034	1.795	1.568	34.767	226.0	110.2	87.22	2.22	29.89							
14	3543	1.035	0.776	34.714	213.0	130.4	93.54	2.26	30.50							
15	4044	0.395	0.103	34.678	221.7	127.9	116.25	2.48	33.13							
16	4553	0.206	-0.134	34.669	143.4	208.4	125.45	2.55	32.96							

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Station 10 Position 35.308S 48.018W Depth = 4759 m Date = 9/08/89 Time = 1200Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.074	16.074	35.852	239.4	1.7	0.26	0.01	1.47	2065		302	345.7	-43	2363	
2	10	15.914	15.912	35.809	239.4	2.6	0.26	0.19	1.30	2062						8.38
3	20	15.874	15.871	35.789	239.4	2.8	0.26	0.18	1.47	2060						8.40
4	50	15.864	15.856	35.800	239.4	2.9	0.26	0.12	1.12	2061						8.38
5	102	15.978	15.962	35.818	213.3	28.4	2.46	0.81	10.16							
6	298	12.685	12.644	35.187	213.2	46.3	4.65	0.84	10.42							
7	504	7.121	7.073	34.418	234.9	59.9	13.16	1.68	22.40							
8	810	4.272	4.211	34.222	256.6	59.4	28.36									
9	1013	3.441	3.369	34.247	234.8	87.7	34.93	2.27	29.84							
10	1498	2.829	2.723	34.510	191.3	135.8	58.08	2.47	32.09							
11	2019	2.869	2.717	34.746	195.6	131.0	60.58	2.19	28.72							
12	2647	2.605	2.399	34.829	217.3	111.7	59.63	1.94	25.62							
13	3026	2.185	1.950	34.814	221.7	111.2	69.96	2.03	26.25							
14	3538	1.235	0.971	34.732	213.0	128.6	99.98	2.32	31.37							
15	4044	0.538	0.242	34.685	217.3	130.9	114.69	2.46	32.96							
16	4556	0.184	-0.156	34.662	217.3	134.7	106.25	2.37	31.89							

Station 11 Position 35.318S 48.433W Depth = 4200 m Date = 9/08/89 Time = 1919Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	15.914	15.914	35.855	243.7	-1.8	0.56	0.01	0.81	2063		308	345.9	-38	2354	
2	10	15.834	15.832	35.813	243.7	-1.4	0.56	0.16	0.81	2059						8.38
3	20	15.794	15.791	35.812	243.7	-1.2	0.56	0.18	1.26	2053						8.40
4	50	15.784	15.776	35.811	239.4	3.2	0.87	0.25	1.45	2064						8.38
5	99	15.836	15.820	35.820	239.4	3.0	2.12	0.25	1.71							
6	201	14.944	14.913	35.631	230.7	16.4	0.87	0.35	3.88							
7	308	13.873	13.828	35.390	217.6	35.3	2.12	0.65	7.86							
8	504	8.966	8.911	34.617	221.9	60.5	9.35	1.43	19.62							
9	800	4.748	4.684	34.225	256.6	55.7	16.82	2.00	27.21							
10	1008	3.410	3.338	34.547	247.8	74.2	31.35	2.18	30.45							
11	1515	2.829	2.722	34.471	195.6	131.6	59.70	2.52	34.60							
12	2025	3.031	2.876	34.752	200.0	125.3	58.45	2.15	29.35							
13	2526	2.684	2.488	34.810	221.7	106.7	60.00	2.03	27.36							
14	3031	2.216	1.980	34.814	226.0	106.6	72.14	1.96	27.19							
15	3539	1.255	0.991	34.743	226.0	115.3	103.29	2.22	31.24							
16	4077	0.354	0.060	34.671	221.7	128.3	124.46	2.46	33.27							

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Station 12		Position	35.377S	49.543W		Depth = 4251 m			Date =	9/09/89		Time =	0227Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.644	17.644	36.126	235.1	-1.5				2048		305	345.2	-41		8.43
2	10	17.644	17.642	36.087	235.1	-1.5				2047						8.42
3	20	17.654	17.651	36.083	235.1	-1.5				2053						8.40
4	50	17.674														
5	102	17.647	17.630	36.136	217.7	15.9	2.89	0.08	0.89		2059					8.42
6	310	16.083	16.033	35.866	230.7	10.6	2.07	0.20	8.31	2063						8.39
7	509	12.061	11.993	35.067	213.2	50.1	7.01	0.93	13.72	2095						8.29
8	815	5.256	5.188	34.243	256.6	51.9	14.25	1.84	26.30	2132						8.10
9	1014	4.031	3.954	34.213	252.2	65.7	25.75	2.13	34.63		2153					8.08
10	1519	2.801	2.694	34.429	191.3	136.3	59.73	2.53	37.73		2215					7.96
11	2367	3.407	3.213	34.911	239.1	83.1	36.15	1.57	25.36		2169					8.11
12	2664	3.143	2.924	34.913	247.7	76.8	35.88	1.49	22.92		2164					8.12
13	2829	2.927	2.696	34.907	243.4	83.0	40.81	1.52	22.91		2177					8.10
14	3235	2.165	1.909	34.828	230.4	102.8	66.83	1.84	26.54		2201					8.07
15	3740	0.762	0.491	34.694	213.0	133.0	117.52	2.34	34.07		2248					8.03
16	4175	0.149	-0.149	34.659	221.7	130.3	128.49	2.49		2253						8.05

XBT 7		Position				Depth =			Date =	9/09/89		Time =	0900Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.45										312	345.0	-33		

Station 13		Position	35.398S	50.998W		Depth = 3018 m			Date =	9/09/89		Time =	1200Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.984	17.984	36.285	235.1	-3.3	0.87	0.08	0.37	2055		303	345.0	-42	2376	8.45
2	10	18.204	18.202	36.176	235.1	-4.1	1.73	0.12	0.43	2054						8.44
3	20	18.224	18.221	36.174	230.7	0.2	0.58	0.10	0.30	2051						8.42
4	50	18.204					6.85	0.08	0.68							8.42
5	100	17.946	17.929	36.168	226.4	5.8	0.30	0.07	0.84	2060						8.47
6	311	15.303	15.255	35.598	200.2	45.2	1.45	0.44	4.69							8.37
7	607	10.554	10.480	34.847	204.5	67.9	8.05	1.26	17.27	2121						8.15
8	820	5.814	5.742	34.305	243.6	60.8	14.37	1.86	25.09	2136						8.15
9	1009	4.084	4.008	34.192	256.6	61.0	23.12	2.09	27.80	2150						8.11
10	1530	2.990	2.880	34.428	200.0	126.0	47.82	2.44	32.44	2209						8.02
11	1821	3.353	3.213	34.676	165.2	157.6	42.93	2.16	29.56	2202						8.09
12	2013	3.580	3.418	34.799	217.3	103.5	39.48	1.87	26.57	2188						8.12
13	2231	3.656	3.471	34.891	234.7	85.5	31.15	1.62	23.22	2171						8.12
14	2425	3.399	3.199	34.912	243.4	78.9	32.01	1.53	22.84	2165						8.12
15	2623	2.845	2.636	34.882	247.7	79.2	40.05	1.57	22.56	2173						8.12
16	2943	1.644	1.429	34.747	221.7	115.8										

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Station 14 Position 35.368S 51.748W Depth = 2245 m Date = 9/09/89 Time = 1850Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	18.534					7.41	0.14	0.00	2045		304	345.0	-41		8.49
2	10	18.554	18.552	36.253	230.7	-1.4	3.36	0.19	0.00	2052						8.49
3	20	18.534	18.530	36.259	230.7	-1.3	2.47	0.17	0.00	2051						8.42
4	40	18.554	18.547	36.363	230.7	-1.5	2.31	0.16	0.18	2054						8.46
5	102	18.543	18.525	36.327	226.4	3.0	4.91	0.01	0.55	2055						8.48
6	198	17.962	17.928	36.139	209.0	23.3	3.87	0.06	0.54	2062						8.39
7	305	15.225	15.178	35.579	213.3	32.6	3.87	0.44	5.16	2081						8.26
8	521	10.054	9.992	34.816	200.1	75.2	10.89	1.30	18.91	2124						8.16
9	710	6.341	6.276	34.393	217.5	82.9	17.62	1.89	27.14	2143						8.15
10	913	4.569	4.497	34.263	230.5	83.2	26.33	2.10	30.13	2158						8.12
11	1115	3.660	3.578	34.249	226.1	94.7	33.32	2.24	31.93	2171						8.09
12	1328	3.150	3.055	34.328	208.7	116.1	47.06	2.44	33.92	2200						8.09
13	1517	3.071	2.961	34.449	191.3	134.0	52.75	2.47	34.99	2214						8.09
14	1714	3.389	3.258	34.628	195.6	126.9	47.56	2.22	31.38	2205						8.16
15	1920	3.677	3.522	34.869	230.4	89.5	33.05	1.64	24.68	2171						8.48
16	2118	3.312	3.144	34.891	226.0	96.8										8.48

Station 15 Position 35.457S 52.280W Depth = 1381 m Date = 9/10/89 Time = 0254Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.854					6.41	0.16	0.00	2015						
2	10	16.964	16.962	35.215	239.5	-1.5	3.60	0.09	0.00	2025						8.32
3	20	17.134	17.131	35.233	239.6	-2.3	3.60	0.09	0.00	2025						
4	50	17.644					4.74	0.11	0.64	2051						
5	98	18.751	18.734	36.161	217.7	11.1	4.95	0.07	0.23		2058					
6	206	15.347	15.315	35.582	195.9	49.3	3.87	0.44	6.21							
7	305	10.091	10.055	34.819	204.5	70.5	12.13	1.22	18.52							
8	405	7.451	7.411	34.508	213.1	79.2	16.16	1.63	24.53							
9	505	5.923	5.879	34.354	230.5	72.7	16.97	1.79	26.60							
10	607	5.055	5.006	34.277	239.2	70.6	19.94	1.83	27.13							
11	710	4.515	4.460	34.267	234.9	79.1	26.17	1.93	28.63							
12	812	4.147	4.086	34.258	230.5	86.4	29.13	2.09	30.46							
13	912	3.590	3.525	34.248	234.8	86.5	33.71	2.18	31.35							
14	1014	3.327					40.63	2.33	33.74							
15	1114	3.272					47.60	2.40	34.92		2193					
16	1322	3.020														

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XBT 8 Sample ID	Pres (dbar)	Position T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	Depth = AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/10/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	0345Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.61								2049		297	345.5	-48		

Station 16 Sample ID	Pres (dbar)	Position T insit (deg C)	36.487S Theta (deg C)	50.808W Sal (PSU)	O2 (uM/kg)	Depth = 3800 m AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/10/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	0947Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	16.924	16.924	35.859	243.8	-6.6	1.94	0.19	0.18	2039		288	345.5	-58	2355	
2	10	16.984	16.982	35.830	230.7	6.2	1.34	0.01	0.00	2044						
3	20	16.984	16.981	35.834	243.8	-6.8	1.03	0.19	0.00	2046						
4	50	17.024	17.016	35.862	243.8	-7.0	1.34	0.19	0.00	2046						
5	80	16.405	16.392	35.744	243.8	-4.0	1.64	0.04	0.71							
6	81	16.585	16.572	35.763	243.8	-4.8	1.03	0.05	0.53							
7	303	10.461	10.425	34.822	213.2	59.5	9.61	1.06	16.81							
8	501	6.683	6.637	34.423	226.2	71.6	16.21	1.60	25.76							
9	763	4.374	4.316	34.233	252.3	62.9	26.12	1.83	29.30							
10	1301	2.945	2.855	34.366	208.7	117.7	54.03	2.17	34.16							
11	1616	3.034	2.916	34.588	186.9	138.4	65.43	2.16	34.25							
12	2000	3.377	3.219	34.804	213.0	109.4	50.72	1.73	28.40							
13	2321	3.045	2.862	34.826	217.3	107.9	57.92	1.69	27.95							
14	2635	2.988	2.775	34.868	234.7	91.1	51.91	1.50	25.29							
15	3035	2.754	2.505	34.890	247.7	80.3	46.81	1.37	23.17							
16	3695	0.867	0.597	34.698	213.0	132.0	125.12	2.14	33.62							

Station 17 Sample ID	Pres (dbar)	Position T insit (deg C)	36.510S Theta (deg C)	51.387W Sal (PSU)	O2 (uM/kg)	Depth = 3700 m AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	Date = NO3 (uM/kg)	9/10/89 TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	Time = pCO2 (sw) (uatm)	1355Z pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.744	17.744	35.913	235.1	-1.7	2.61	0.03	0.18	2042		301	345.1	-44	2356	
2	10	17.724	17.722	35.927	235.1	-1.6	1.45	0.09	0.00	2039						
3	20	17.734	17.731	35.850	239.5	-5.9	1.17	0.01	0.00	2044						
4	50	18.444	18.435	35.848	235.2	-4.6	0.87	0.01	0.18	2050						
5	103	18.202	18.184	36.202	222.0	9.0	0.00	0.03	0.42		2061					
6	304	14.887	14.841	35.531	213.3	34.3	0.87	0.37	5.07	2084						
7	508	9.917	9.858	34.714	213.2	63.1	6.91	1.13	16.57		2119					
8	715	5.323	5.263	34.244	252.3	55.7	12.38	1.66	24.50	2131						
9	912	4.235	4.165	34.210	252.3	64.1	18.13	1.85	27.26		2161					
10	1114	3.347	3.268	34.224	239.2	84.2	29.76	2.02	29.49		2174					
11	1416	2.884	2.785	34.404	195.7	131.2	47.60	2.24	32.51	2205						
12	1723	2.899	2.773	34.609	186.9	139.6	56.21	2.16	32.51		2218					
13	2122	3.225	3.058	34.814	213.0	110.7	42.97	1.72	26.89	2197						
14	2531	3.333	3.124	34.928	230.4	92.5	29.75	1.28	21.54							
15	3031	2.255	2.018	34.830	247.7	84.5	57.07	1.65	25.82		2210					
16	3548	0.755	0.503	34.688	213.0	132.9	102.50	2.18	32.86		2247					

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Station 18 Position 36.497S 51.873W Depth = 3307 m Date = 9/10/89 Time = 1857Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	18.194	18.194	36.231	235.1	-4.1	6.22	0.10	0.00	1982		300	344.9	-45	2291	8.39
2	10	18.184	18.182	36.266	235.1	-4.1	6.22	0.10	0.89	2062						8.32
3	20	18.224	18.221	35.833	235.2	-3.7	3.54	0.10	0.00	2012						8.37
4	50	18.144	18.135	36.138	230.7	0.6	3.54	0.09	0.00	2050						8.41
5	101	17.806	17.789	36.135			1.78	0.09	0.71							
6	204	17.696	17.661	36.155			2.48	0.09	0.89							
7	304	15.039	14.993	35.528			3.28	0.19	5.42							
8	507	11.681	11.615	35.032			6.22	0.87	13.43							
9	710	7.162	7.093	34.487			16.55	1.31	23.95							
10	910	4.634	4.562	34.247			24.91	1.57	27.59							
11	1212	3.311	3.224	34.290			42.52	2.01	32.49							
12	1619	2.832	2.716	34.516			64.67	2.12	34.17							
13	2023	3.079	2.924	34.740			58.80	1.82	29.81							
14	2424	3.270	3.073	34.870			46.77	1.43	23.57							
15	2831	2.875	2.645	34.874			47.05	1.42	23.39							
16	3231	1.802	1.555	34.767			87.62	1.82	29.71							

Station 19 Position 36.577S 52.443W Depth = 3000 m Date = 9/10/89 Time = 2324Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	18.184	18.184	35.948	230.8	0.7	2.73	0.13	0.18	2042		306	344.9	-39	2357	8.36
2	10	18.234	18.232	35.878	230.8	0.6	3.29	0.17	0.09	2029						8.37
3	20	18.274	18.271	36.026	226.4	4.5	2.73	0.19	0.09	2052						8.35
4	50	18.324	18.315	36.225	226.4	4.1	1.33	0.19	0.54	2051						8.39
5	102	18.154	18.136	36.204	226.4	4.9	1.05	0.19	0.54							
6	205	15.789	15.757	35.687	217.6	25.3	2.62	0.27	3.54							
7	306	13.868	13.824	35.383	204.5	48.4	3.85	0.53	7.54							
8	509	9.388	9.330	34.740	204.5	75.0	12.99	1.27	19.74							
9	710	5.801	5.739	34.361	230.5	73.7	19.59	1.72	26.68							
10	915	4.313	4.243	34.258	234.9	80.8	29.87	1.87	29.43							
11	1117	3.531	3.450	34.285	221.8	100.0	41.06	2.09	31.95							
12	1323	3.179	3.084	34.378	204.4	120.1	52.36	2.20	33.43							
13	1620	3.173	3.053	34.601	191.3	132.9	55.87	2.05	31.47							
14	1923	3.580	3.427	34.808	213.0	107.7	37.69	1.36	22.12							
15	2330	3.253	3.065	34.913	243.4	80.0	37.40	1.37	22.30							
16	2747	2.270	2.061	34.820	230.4	101.5	68.56	1.67	26.39							

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Station 20 Position 36.703S 52.988W Depth = 2231 m Date = 9/11/89 Time = 0433Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	9.024	9.024	33.838	348.3	-65.0	10.61	0.36	5.44	1997		232	349.0	-117	2259	8.32
2	10	9.374	9.373	33.823	339.6	-58.5	9.78	0.49	4.70	1997						8.32
3	20	8.614	8.612	33.805	352.6	-66.7	7.54	0.58	4.60	1993						8.34
4	50	6.984	6.979	34.019	95.7	200.6	7.54	0.53	3.85	1984						8.35
5	103	6.149	6.140	34.016			10.89	1.28	19.73							
6	210	5.282	5.265	34.096			11.73	1.40	21.87							
7	415	4.958	4.926	34.169			14.80	1.52	24.21							
8	615	4.454	4.407	34.174			23.11	1.72	27.00							
9	815	3.954	3.894	34.209			32.04	1.91	30.17							
10	1016	3.222	3.152	34.249			42.37	2.09	32.51							
11	1215	2.873	2.790	34.336			54.36	2.22	34.19							
12	1423	3.150	3.047	34.509			53.80	2.17	32.41							
13	1614	3.221	3.101	34.634			51.56	1.99	30.54							
14	1822	3.578	3.434	34.807			42.35	1.68	26.80							
15	2019	3.540	3.378	34.864			39.27	1.51	24.75							
16	2224	3.369	3.190	34.885			39.84	1.43	23.63							

Station 21 Position 36.457S 53.067W Depth = 1300 m Date = 9/11/89 Time = 0935Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	17.514	17.514	35.605	235.2	-0.2	3.50	0.08	0.19	2035		299	345.2	-46	2345	8.38
2	10	17.544	17.542	35.505	235.2	-0.2	3.82	0.10	0.09	2036						8.39
3	20	17.644	17.641	35.546	235.2	-0.7	3.50	0.03	0.00	2035						8.39
4	50	16.954	16.946	35.543	226.4	11.2	2.54	0.12	1.52	2061						8.37
5	-9															
6	-9															
7	-9															
8	-9															
9	-9															
10	-9															
11	-9															
12	-9															
13	-9															
14	-9															
15	-9															
16	1238	3.132	3.045	34.298	217.4	107.6				2195						8.00

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Station 22		Position	36.530S	53.653W		Depth = 805 m			Date =	9/11/89		Time =	1558Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	9.117	9.117	33.869			6.36	0.43	0.00		1848	124	348.1	-224	2236	8.38
2	9	7.746	7.745	33.894	330.8	-39.4	7.32	1.02	13.47							8.28
3	10															
4	21	6.953	6.951	33.924	291.6	5.1	7.95	1.24	18.71							8.18
5	20															
6	50															
7	51	6.661	6.656	33.936	291.5	7.2	7.95	1.26	19.19							8.18
8	102	6.130	6.121	34.001	291.5	10.8	8.27	1.32	20.75							8.15
9	154	5.552	5.540	34.083	295.8	10.5	9.22	1.38	21.61							8.14
10	205	5.249	5.233	34.124	291.5	17.0	10.18	1.47	23.23							8.12
11	254	5.054	5.034	34.138	291.4	18.5	10.81	1.47	23.69							8.13
12	300	5.021	4.998	34.145	287.1	23.1	12.72	1.50	24.03							8.07
13	400	4.980	4.949	34.159	287.1	23.4	12.40	1.51	24.23							8.15
14	501	4.737	4.698	34.170	278.4	34.0	15.26	1.58	25.59							8.12
15	603	4.480	4.434	34.179	269.7	44.7	19.71	1.70	27.14							8.10
16	718	4.165	4.112	34.196	256.6	60.2	26.52	1.82	29.08							8.07

Station 23		Position	39.515S	53.017W		Depth = 4900 m			Date =	9/12/89		Time =	0754Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	13.804	13.804	34.558	291.8	-37.2	7.52	0.10	0.00	1982		239	346.6	-108	2289	8.10
2	10	13.484	13.483	34.556	283.0	-26.8	6.26	0.09	0.00							8.45
3	20	11.844	11.841	34.745	265.5	-0.7	5.63	0.14	0.00							8.42
4	50	11.014	11.008	34.336	278.6	-8.3	4.70	0.55	4.73							8.32
5	104	9.594	9.582	34.437	269.8	8.8	6.25	0.79	10.82		2081					8.30
6	204	7.385	7.366	34.267	265.4	27.8	8.76	1.22	18.69		2105					8.20
7	459	4.804	4.769	34.173	278.4	33.5	15.33	1.54	24.06		2137					8.15
8	799	3.842	3.784	34.245	243.5	75.7	31.46	1.87	29.33		2168					8.10
9	1014	3.517	3.444	34.278	230.5	91.4	46.47	2.06	32.11		2194					8.05
10	1517	2.923	2.815	34.558	191.3	135.0	64.27	2.07	32.37		2235					8.00
11	2023	2.943	2.790	34.750	204.3	121.7	63.01	1.79	28.70		2223					8.06
12	2453	3.026	2.831	34.871	234.7	90.7	50.19	1.45	23.96		2192					8.18
13	3032	2.082	1.849	34.786	217.3	116.5	83.01	1.75	27.80		2225					8.07
14	3536	1.183	0.921	34.714	217.3	124.7	116.13	2.01	31.19		2245					8.00
15	4040	0.558	0.262	34.673	217.3	130.8	119.26	2.04	31.55							7.99
16	4375	0.284	-0.039	34.662	226.0	124.9	133.01	2.13	32.81		2253					8.01

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Station 24		Position	39.313S	53.733W		Depth = 4200 m			Date =	9/12/89		Time =	1813Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	14.914	14.914	35.180	265.6	-17.7	3.55	0.14	0.26		2036	315	346.2	-31	2302	8.41
2	10	15.334	15.332	35.001	265.6	-19.5	3.08	0.07	0.18							8.38
3	20	15.854	15.851	35.777	248.1	-5.8	2.48	0.02	0.18		2046					8.42
4	50			35.484			3.35	0.28	3.57							8.35
5	105	12.495	12.481	35.114	230.6	29.9	3.67	0.60	8.55		2088					8.27
6	208	9.082	9.059	34.670	217.5	63.8	9.80	1.16	18.37							8.17
7	408	4.956	4.924	34.221	265.3	45.2	14.55	1.56	24.88							8.09
8	594	4.161	4.117	34.216	256.6	60.1	23.48	1.70	26.81							8.06
9	808	3.283	3.228	34.267	230.5	93.1	36.85	1.95	30.24							8.06
10	1219	2.700	2.618	34.451	191.3	136.8	60.29	2.15	32.53							7.96
11	1622	2.889	2.772	34.664	186.9	139.4	64.73	2.00	30.76							7.99
12	2030	3.004	2.849	34.809	213.0	112.4	55.83	1.66	26.19							8.02
13	2530	2.299	2.110	34.776	217.3	114.3	74.22	1.78	27.67							8.02
14	3021	1.908	1.680	34.774	213.0	122.3	83.72	1.78	27.59							8.01
15	3539	1.126	0.865	34.710	208.6	133.9	111.61	2.09	31.02							7.98
16	4053	0.242	-0.046	34.664	217.3	133.7	127.33	2.20	31.99		2329					7.97

Station 25		Position	39.115S	54.248W		Depth = 2000 m			Date =	9/13/89		Time =	0000Z			
Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	6.714	6.714	34.064	308.9	-10.9	6.75	1.20	17.38	2066		336	348.4	-12	2247	8.25
2	10	6.864	6.863	34.066	308.9	-11.9	5.73	1.18	17.38	2047						8.25
3	20	6.384	6.382	34.041	313.3	-12.9	5.42	1.24	17.29	2082						8.29
4	50	5.514	5.510	34.041	308.9	-2.2	6.63	1.29	18.36							8.22
5	102	5.047	5.039	34.067	304.5	5.6	8.74	1.38	20.76	2042						8.31
6	203	4.590	4.575	34.111	300.1	13.3	11.15	1.47	22.54	2058						8.06
7	305	4.333	4.311	34.139	287.1	28.3	14.47	1.59	24.42	2070						8.26
8	405	3.945	3.917	34.184	256.6	61.8	26.50	1.80	27.55	2092						8.16
9	507	3.744	3.709	34.224	239.2	80.7	33.14	1.91	28.97	2094						8.15
10	607	3.523	3.481	34.250	234.8	86.8	37.05	1.97	30.03	2125						8.10
11	810	2.903	2.850	34.321	221.8	104.8	48.80	2.13	31.91	2143						8.10
12	1008	2.686	2.620	34.408	139.1	189.1	62.95	2.24	32.98	2161						8.04
13	1215	2.523	2.443	34.465	187.0	142.6	69.28	2.25	33.41	2227						8.11
14	1417	2.435	2.340	34.521	178.2	152.0	75.30	2.24	33.24	2203						8.02
15	1619	2.381	2.271	34.558	178.2	152.5	78.01	2.25	32.79	2238						8.03
16	1972	2.443	2.302	34.701	191.3	138.9	76.49	2.00	30.02	2231						8.06

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Station 26 Position 38.960S 54.812W Depth = 900 m Date = 9/13/89 Time = 0411Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	7.114	7.114	33.996	309.0	-13.5	6.66	1.07	15.35		2048	334	348.6	-14	2230	8.12
2	10															
3	11	6.923	6.922	33.958	313.3	-16.5	7.62	1.07	15.72	1983						8.20
4	20	6.605	6.603	33.956	295.9	3.1	7.94	1.14	16.81	2024						8.17
5	20															
6	50															
7	51	6.070	6.066	34.002	308.9	-6.2	8.89	1.27	19.26	2049						8.18
8	102	5.747	5.739	34.060	295.8	9.1	9.52	1.34	20.43	2043						8.12
9	203	5.129	5.113	34.136	295.8	13.6	10.79	1.42	21.88	2038						8.12
10	302	4.984	4.961	34.174	287.1	23.3	12.38	1.47	22.88	2106						8.10
11	406	4.724	4.693	34.180	278.4	34.0	14.60	1.55	24.06		2105					8.09
12	506	4.442	4.404	34.191	269.7	44.9	18.09	1.67	25.52		2108					8.08
13	609	4.019	3.975	34.267	252.2	65.5	27.76	1.81	27.14		2137					8.05
14	709	3.633	3.583	34.245	230.5	90.3	36.00	1.97	29.51		2182					8.00
15	808	3.176	3.122	34.293	221.8	102.6	44.38	2.08	31.05		2182					8.00
16	889	3.141	3.081	34.307	217.4	107.3	46.47	2.11	31.33		2220					7.98

Station 27 Position 38.738S 55.295W Depth = 388 m Date = 9/13/89 Time = 0722Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	6.664					7.47	1.25	17.11							8.25
2	4	6.954	6.954	33.952	304.6	-8.0	7.56	1.15	16.70							8.25
3	10	6.949	6.948	33.949	304.6	-7.9	7.23	1.15	16.79							8.25
4	10															
5	20	6.714	6.712	33.953	304.6	-6.3	6.90	1.16	16.97							8.23
6	20															
7	50															
8	53	6.101	6.097	34.005	295.9	6.6	7.23	1.28	19.00							8.21
9	82	5.811	5.804	34.352	295.8	8.1	7.56	1.30	19.54							8.20
10	103	5.600	5.592	34.066	295.8	10.2	7.56	1.32	19.83							8.20
11	134	5.434	5.423	34.088	300.2	7.0	8.21	1.35	20.47							8.19
12	174	5.221	5.207	34.113	300.2	8.6	8.21	1.37	21.03							8.19
13	203	5.174	5.158	34.121	295.8	13.3	8.54	1.38	21.30							8.18
14	254	5.080	5.060	34.150	291.4	18.3	9.85	1.43	21.86							8.16
15	304	4.892	4.869	34.168	282.7	28.4	12.48	1.51	23.14							8.15
16	383	4.618	4.589	34.182	274.0	39.2	15.76	1.61	24.33							8.12

Sta 27.1 Position 38.352S 56.600W Depth = Date = 9/13/89 Time = 1256Z

Sample ID	Pres (dbar)	T insit (deg C)	Theta (deg C)	Sal (PSU)	O2 (uM/kg)	AOU (uM/kg)	SiO2 (uM/kg)	PO4 (uM/kg)	NO3 (uM/kg)	TCO2 (uM/kg) --SHIP--	TCO2 (uM/kg) --LAB--	pCO2 (sw) (uatm)	pCO2 (air) (uatm)	D pCO2 (sw-air) (uatm)	TALK (ueq/kg)	pH
1	0	19.16	19.160	33.633								301	344.5	-43		

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APPENDIX 1 - Computer program for the calculation of the alkalinity.

```
REM FILE NAME = TALK.BAS

REM THIS IS TO COMPUTE TALK (uEQ/KG) FROM TCO2 AND PCO2 USING
REM MEHRBACH K1 AND K2 FOR CARBONIC ACID, LYMAN KB FOR BORIC ACID,
REM WEISS CO2 SOLUBILTIY, KESTER & PYTKOWICZ KP2 AND KP3 FOR PHOSPHORIC ACID,
REM SILLEN & MARTEL KSI FOR SILICIC ACID, AND MILLERO'S FRMULATION OF KW.

DEFDBL A-Z

100

CLS

LINE INPUT "Enter sample number       :"; SP$
INPUT "Enter temperature in C     : ", Tc
INPUT "Enter salinity in o/oo     : ", SA
INPUT "Enter Total CO2 in uM/kg   : ", CT
INPUT "Enter pCO2 in uatm         : ", pC
INPUT "Enter silica in uM/kg      : ", Si
INPUT "Enter phosphate in uM/kg   : ", Po

Tk = Tc + 273.15
CT = CT * .000001
pC = pC * .000001
Si = Si * .000001
Po = Po * .000001

REM COMPUTE CO2 SOLUBILITY IN SEAWATER IN MOLES/ATM.KG.SW

k0 = EXP(-60.2409 + 9345.17 / Tk + 23.3585 * LOG(Tk / 100) + SA * (.023517 - 2.3656E-04 * Tk + 4.7036E-07 * Tk * Tk))

REM COMPUTE K1 AND K2 OF CARBONIC ACID IN SEAWATER

K1 = EXP(2.302585# * (13.7201 - .031334 * Tk - 3235.76 / Tk - .000013 * SA * Tk + .1032 * SQR(SA)))

K6 = -5371.9645# - 1.871221# * Tk - .22913 * SA + 128375.28# / Tk + 8.0944E-04 * Tk * SA - 2.136 * SA / Tk

K7 = -18.3802 * LOG(SA) + 2184.3055# * LOG(Tk) + (5617.11 / Tk) * LOG(SA)

K2 = EXP(K7 + K6 * 2.302585#)

REM COMPUTE KB,KP2 AND KP3

KB = EXP(2.302585# * (-9.26 + .00886 * SA + .01 * Tc))
K3 = EXP(-8.038 - 1450 / Tk)
K4 = EXP(4.466 - 7276 / Tk)
K5 = 4E-10

REM COMPUTE DISSOCIATION CONSTANT FOR WATER

KW = EXP(148.9802# - 13847.26# / Tk - 23.6521 * LOG(Tk) + (-79.2447 + 3298.72 / Tk + 12.0408 * LOG(Tk)) * SQR(SA) - .019813 * SA)

REM ACTIVITY OF HYDROGEN ION IN SEAWATER BASED ON TAKAHASHI FORMULATION OF CULBERSON&OOPYTKOWICZ DATA

FH = 1.29 - .00204 * Tk + .000461 * SA * SA - 1.48E-06 * SA * SA * Tk

REM TOTAL BORON IS BASED ON CULKIN

Tb = .0004106 * SA / 35
```

```
REM COMPUTE AH USING PCO2 AND TCO2

CU = k0 * pC
h = (K1 + SQR(K1 * K1 + 4 * K1 * K2 * (CT / CU - 1))) / (2 * (CT / CU - 1))
pH = -LOG(h) / 2.30258

REM COMPUTE TOTAL ALKALINITY

AC = k0 * pC * (K1 / h + 2 * K1 * K2 / (h * h))
AB = KB * Tb / (h + KB)
AS1 = K5 * Si / (h + K5)
AP = Po * (1 / (1 + K3 / h + K3 * K4 / (h * h)) + 2 / (1 + h / K3 + K4 / h) + 3 / (1 + h / K4 + h * h / (K3 * K4)))
AW = KW * FH / h - h / FH
AT = AC + AB + AS1 + AP + AW
CB = K1 * CU / h
CC = K2 * CB / h

PRINT
PRINT "TALK (uEq/kg) = "; AT * 1000000!
PRINT "H2CO3 (uM/kg) = "; CU * 1000000!
PRINT "HCO3- (uM/kg) = "; CB * 1000000!
PRINT "CO3=  (uM/kg) = "; CC * 1000000!
PRINT
PRINT USING "K0 = +#.########^^^^          K1 = +#.########^^^^"; k0, K1
PRINT USING "K2 = +#.########^^^^          KB = +#.########^^^^"; K2, KB
PRINT USING "KW = +#.########^^^^          fH = +#.########^^^^"; KW, FH

PRINT USING "aH = +#.########^^^^          pH = ##.########"; h, pH

PRINT
INPUT "Press <ENTER> to continue"; A$
GOTO 100
```